NAVY
13.1 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

The responsibility for the implementation, administration and management of the Navy SBIR Program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, john.williams6@navy.mil For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic from **16 November through 16 December 2012.** Beginning **17 December 2012**, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in Section 4.15.d of the DoD Program Solicitation must be used for any technical inquiry.

Protests of Phase I and II selections and awards shall be directed to the cognizant Contracting Officer for the Navy Topic Number. Contracting Officer contact information may be obtained from the Navy SYSCOM SBIR Program Manager Point of Contact listed in Table 1 below.

TABLE 1: NAVY SYSCOM SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N131-001 thru N131-018	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N131-019 thru N131-021	Mr. Nick Olah	NAVFAC	nick.olah@navy.mil
N131-022 thru N131-060	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N131-061 thru N131-083	Ms. Lore Anne Ponirakis	ONR	loreanne.ponirakis@navy.mil

The Navy's SBIR Program is a mission oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at **www.dodsbir.net/solicitation** for program requirements and proposal submission. It is highly recommended that you follow the Navy proposal template located at http://www.navysbir.com/navsea as a guide for structuring your proposal. Cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings are recommended for all proposals and required for proposals submitted to NAVSEA.

Volume 2 Technical Volumes that exceed the 20 page limit will be reviewed only to the last word on the 20th page. Information beyond the 20th page will not be reviewed or considered in evaluating the Offeror's proposal. To the extent that mandatory technical content is not contained in the first 20 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

The Navy requires proposers to include, within the **20** page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. **The base amount of the phase I should not exceed $80,000 and six months; the phase I option should not exceed $70,000 and six months.**

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria must be met or your proposal will be REJECTED.

____1. Include a header with company name, proposal number and topic number on each page of your Technical Volume.

____2. Include tasks to be completed during the option period in the 20 page technical volume and include the costs as a separate section in the Cost Volume.

____3. Break out subcontractor, material and travel costs in detail. Use the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information, if necessary.

____**4. The base effort should not exceed $80,000 and have a period of performance of six months and the option should not exceed $70,000 and have a period of performance of six months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the work plan section of the proposal.**

____5. Upload your Technical Volume and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Volume electronically through the DoD submission site by 6:00 am ET, 16 January 2013.

____6. After uploading your file on the DoD submission site, review it to ensure that it appears correctly. Contact the DoD Help Desk immediately with any problems.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in Section 6.0 of the DoD Program Solicitation with technical merit being most important, followed by qualifications and commercialization potential of equal importance. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

One week after solicitation closing, e-mail notifications that proposals have been received and processed for evaluation will be sent. Consequently, e-mail addresses on the proposal coversheets must be correct.

The Navy typically awards a firm fixed price contract or a small purchase agreement for Phase I.

In accordance with section 4.10 of the DoD Instructions, your request for a debrief must be made within 15 days of non-award notification.

PHASE I SUMMARY REPORT

Contract Deliverables (CDRLs), typically progress and final reports, can be uploaded to **http://www.onr.navy.mil/sbir** as required by the contract.

PHASE II GUIDELINES

All Phase I awardees will be allowed to submit an initial Phase II proposal for evaluation and selection. The details on the due date, content, and submission requirements of the initial Phase II proposal will be provided by the awarding SYSCOM either in the Phase I award or by subsequent notification. **All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be**

conducted in accordance with the procedures specified in those solicitations (for all Department of Navy topics this means by invitation only).

Section 4(b)(1)(ii) of the SBIR Policy Directive permits the Department of Defense and by extension the Department of the Navy (DoN), during fiscal years 2012 through 2017, to issue a Phase II award to a small business concern that did not receive a Phase I award for that R/R&D. The DoN will NOT be exercising this authority for Phase II awards. **In order for any small business firm to receive a Phase II award, the firm must be a recipient of a Phase I award under that topic.**

The Navy will evaluate, and select Phase II proposals using the evaluation criteria in Section 8.0 of the DoD Program Solicitation with technical merit being most important, followed by qualifications and commercialization potential of equal importance. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy does NOT participate in the FAST Track program.

The Navy SBIR Program structures Phase II contracts in a way that allows for increased funding levels based on the project's transition potential. This is called the Phase II.5 and is accomplished through either multiple options that may range from $250,000 to $1,000,000 each, substantial expansions to the existing contract, or a second Phase II award. For existing Phase II contracts, the goals of Phase II.5 can be attained through contract expansions, some of which may exceed the $1,000,000 recommended limits for Phase II awards.

All awardees, during the second year of the Phase II, must attend a one-day Transition Assistance Program (TAP) meeting. This meeting is typically held in the summer in the Washington, D.C. area. Information can be obtained at **http://www.dawnbreaker.com/navytap**. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

The Navy typically awards a cost plus fixed fee contract for Phase II.

PHASE II ENHANCEMENT

The Navy has adopted a Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since Phase III awards are permitted during Phase II work, some Navy SYSCOMs may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. For more information, please contact the SYSCOM SBIR Program Manager.

PHASE III

A Phase III SBIR award is any work that derives from, extends or logically concludes effort(s) performed under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description, which includes according SBIR Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect the rights of the SBIR company.

AWARD AND FUNDING LIMITATIONS – In accordance with SBIR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally in accordance with SBIR Policy Directive section 7(i)(1), each award may not exceed the award guidelines (currently $150,000 for Phase I and $1 million for Phase II) by more than 50% (SBIR/STTR program funds only) without a specific waiver granted by the SBA.

TOPIC AWARD BY OTHER THAN THE SPONSORING AGENCY – Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds (see above), Head of Agency Determinations are now required before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact your original sponsoring agency before submitting a Phase II proposal to an agency other than the one who sponsored the original topic. (For DoN awardees, this includes other SYSCOMs.)

TRANSFER BETWEEN SBIR AND STTR PROGRAMS – Section 4(b)(1)(i) of the SBIR Policy Directive provide that, at the agency's discretion, projects awarded a Phase I under a solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact their designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. Agency disapproval of a request to change programs shall not be grounds for granting relief from any contractual performance requirement. All approved transitions between programs must be noted in the Phase II award or award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

ADDITIONAL NOTES

Due to the short timeframe associated with Phase I of the SBIR process, the Navy does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I time to award goals. Before Navy makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact our evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within six months of notification of selection, the award may be terminated. If you are proposing human, animal, and recombinant DNA use under a Phase I or Phase II proposal, you should view the requirements http://www.onr.navy.mil/en/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This website provides guidance and notes approvals that may be required before contract/work can begin.

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NAVY SBIR 13.1 Topic Descriptions

N131-001 TITLE: Innovative approaches to produce narrow, long and curved core passages in large metallic investment castings

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-261

OBJECTIVE: Produce narrow, long and curved core passages in large metallic investment castings.

DESCRIPTION: The newly developed controlled solidification investment casting (CSIC) process provides many advantages over traditional sand casting process such as: 1) thinner walls, 2) better process control, 3) improved mechanical properties, and 4) less defects/more uniform casting quality. With increasing adaptation of the CSIC process within the foundry industry, the process has seen broader acceptance by original equipment manufacturers (OEMs) and aerospace community. However, one critical drawback of the process is its difficulty in handling complex lubrication core passages in comparison with the sand casting process which limits its use for castings with complex lubrication passageways, particularly with large housings for large aircraft.

Normally direct passageway construction process requires large passage diameters [1]. For narrow, long, and curved passageways the current approach relies on a combination of several techniques, such as steel tubes, access ports, and drilling [2, 3]. All these techniques have their own limitations and often bring about more complications to the casting and manufacturing process and none is suitable for castings like helicopter gearboxes with long, narrow and curved core passages. For instance, the steel tube method causes differential thermal expansion leading to cracking, the access port method necessitates welding of the casting degrading quality and the drilling method works only for straight passages. There is strong need of developing innovative techniques to address the complex lubrication core passage issues encountered particularly with military aerospace hardware.

Any new techniques for the construction of core passage of investment casting process should take into account the following requirements: 1) Easy removal after casting, 2) Use of existing mold material, or new material that is compatible with the existing mold material, 3) Eliminating the need for welding, 4) Capable of handling complex lubrication passage structures, 5) Avoiding use of metal other than the casting material, and 6) Attaining uniform casting quality. It is expected that development of such innovative techniques would make it possible to produce large and complex core passage castings in investment casting process with improved manufacturing control and mechanical properties, resulting in significantly enhanced hardware/component reliability and overall cost effectiveness.

PHASE I: Develop an innovative approach that enables the construction of complex cored passageways in aluminum investment casting for military aircraft applications and demonstrate feasibility of the developed concept.

PHASE II: Fully develop the concept demonstrated during Phase I through a process specification and demonstration of industrial reproducibility. Perform testing and property comparisons with the casting hardware end users and develop the data-base.

PHASE III: Perform verification and validation of the developed process and transition the technology to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed cored passageway technology will benefit military and civilian applications equally. Given the factor that transition from magnesium to aluminum gearbox housing hardware is accelerating in both military and commercial helicopter applications, more aluminum housings with complex passageways can benefit from this technology development for a wide range of military aircraft, such as CH-53K, Naval and Black Hawks, and future search and rescue helicopters as well as S-92, 76 aircraft used for off-shore and VIP applications.

REFERENCES:

1. Casting Design and Performance, ASM International, 2009.

2. Aluminum Casting Technology, 2nd edition, AFS, 1986. http://asmcommunity.asminternational.org/portal/site/www/AsmStore/ProductDetails/?vgnextoid=0859781eed0f8110VgnVCM100000701e010aRCRD

3. ASM Handbook, Vol. 15. Casting, 1988. http://www.amazon.com/ASM-Handbook-Volume-15-Casting/dp/B00742ENWI

KEYWORDS: Passageways; Investment Casting; aluminum alloys; Metal castings; Core design; Mold design

N131-002 TITLE: Technologies for the Suppression of Combustion Instability or Screech

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: JSF-Prop

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop innovative technologies for the suppression of combustion instabilities (screech) for thrust augmentors in high-performance gas turbine engines.

DESCRIPTION: Combustion instability, or screech, occurs in many combustion systems. Combustion instability is due to the complex physical coupling of the acoustic resonances in the combustion chamber with fluctuations in the heat release of the combustion process. In modern gas turbine afterburners, instability or screech modes typically occur in the range of frequencies from hundreds to thousands of hertz. Coupling can produce large pressure fluctuations that can be severe enough to damage engine hardware. Three stream engines and the integration of the augmentor, exhaust ducts, and nozzle for next generation gas turbines will increase the desired range of operability for the augmentor and further challenge the ability to manage instabilities.

Historically, screech has been mitigated by two very different approaches; adding damping and altering the coupling or driving. In the case of damping, liners and resonators have been fashioned to absorb acoustic energy. By their nature, acoustic or screech liners are most effective on modes with frequencies greater than 1 kHz. These liners are a cost effective way to reduce instabilities above 1 kHz and improve durability. Resonators are can be tuned to suppress much lower frequency modes, less than 1 kHz. To absorb acoustic energy at these frequencies, the resonators are physically large, introducing a weight impact. Resonators provide excellent suppression of combustion instability in ground-based gas turbine systems, where weight is not a significant factor. In aero systems, current resonator technology has a significant system weight penalty. Integration of screech liners or resonators with multi-stream engines also presents significant integration challenges for future systems.

Altering the coupling or driving for screech involves changing the aerodynamics or at least the fuel delivery to change the spatial or temporal characteristics of the heat release. This is often accomplished empirically since reliable analytical tools do not exist for this complex process. If such changes are needed late in the engine development program, this can be very costly to implement and difficult to retrofit. Another method of altering the heat release is to implement an active control system which will modulate the fuel or air sources depending on the operating condition and instability presence to alter the heat release.

One of the main active control approaches is high bandwidth active control using the fuel, whereby fuel is modulated at the frequency of the instability using an actuator valve. The phase of the modulation is varied actively until sufficient heat release is out of phase with the instability which results in suppression of the instability. Active control methods have demonstrated excellent control of combustion instability in ground-based gas turbine systems, where weight and actuator power consumption are not significant factors. Development of actuators with sufficient driving capability is still an open research area.

Combustion in the augmentor is governed by many unsteady physical processes. Desired are new screech suppression technologies that target the physical processes in the afterburner. New technologies may not be limited to just damping or active control. These new technologies should be developed such that they could easily be implemented in current gas turbine augmentors with little weight or cost consequence. New technologies should also address exhaust integration issues for next generation systems.

Close collaboration with an original equipment manufacturer (OEM) of high-performance afterburners is highly recommended to ensure successful transition of technology concepts at the end of Phase II and in Phase III.

PHASE I: Identify an innovative concept for suppression of combustion instabilities. Develop and demonstrate the feasibility of the concept in a laboratory environment. Identify the experimental methodology to evaluate the influence of the technology on the magnitude and bandwidth of the instabilities observed in modern augmentors and address the feasibility for full-scale implementation.

PHASE II: Further develop the proposed concept and conduct extensive experimental evaluation of the technologies identified in Phase I. Assess the ability of the candidate technology to reduce the magnitude and bandwidth of screech instabilities that occur in modern augmentors. Perform a prototype demonstration of the suppression concept to TRL of 4.

PHASE III: Demonstrate a fully functional screech suppression system on a relevant rig/engine platform if available or if the opportunity exists through TRL 5 or beyond. Address the primary risks for transitioning the approach to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology has the true potential for dual-use applications by suppressing combustion instabilities in both military and civil gas turbine engines because the methodology should be applicable to mainburner combustion instabilities.

In a Military environment, light-weight, and low-cost technologies can be transitioned to military gas turbine OEMs for incorporation into existing and future augmentor design systems.

In a commercial environment, the technology may have many applications in commercial gas turbine, land-based gas turbine power generation, and boiler power generation applications.

REFERENCES:

1. Yu, K.H., Wilson, K.J., & Schadow, K.C. (1998). Liquid-Fueled Active Instability Suppression. Twenty-Seventh Symposium (International) on Combustion/ Proceedings of the Combustion Institute, Vol. 27 (2), pp. 2039-2046

2. Yu, K.H., & Wilson, K.J. (2002). Scale-Up Experiments on Liquid-Fueled Active Combustion Control. Journal of Propulsion & Power, Vol. 18 (1), pp. 53-60

3. Yu, K.H., Parr, T.P., Wilson, K.J., Schadow, K.C., & Gutmark, E.J. (1996). Active Control of Liquid-Fueled Combustion Using Periodic Vortex-Droplet Interaction. Twenty-Sixth Symposium (International) on Combustion/Proceedings of the Combustion Institute, Vol. 26 (2), pp. 2843-2850.

KEYWORDS: Combustion instability, screech, active combustion control, active flow control, active instability suppression, augmentor instability

N131-003 TITLE: Rapid and Accurate High-Resolution Radar Signature Prediction of Sea Targets

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PMA 290

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a software tool integrating high- and low-frequency techniques to accurately and rapidly predict high-resolution radar signatures of sea targets.

DESCRIPTION: At X-band and above, boats and ships at sea present rich radar signatures with high potential as the basis of automated target identification. The development and testing of target identification algorithms depends on the rapid and accurate generation of high-resolution radar signatures under diverse sensor conditions and sea states. Raw radar cross section (RCS) is equally important from the perspective of target detection.

At these frequencies, even small boats are electrically large, suggestive of a high-frequency (asymptotic) approach. When the immediately surrounding sea state is considered, the need for a high-frequency approach is magnified. Over a broad range of frequencies, electromagnetic interaction of the boat with a non-uniform sea surface can significantly influence its overall signature. However, boats and ships include smaller structures that may contribute significantly to the overall RCS and feature prominently in high-resolution signatures. Owing to the modest electrical size of these topside features, exclusive reliance on asymptotic methods is insufficient. These component structures are more suitably captured using low-frequency (full-wave) techniques.

More generally, the large-scale structure of the ship or boat that is well modeled with a high-frequency method may not be the dominant source of radar return. Even though the broad structures scatter more of the incident radar wave than the detailed features, these structures tend to scatter energy in particular directions far away from the radar sensor. At the same time, there are many detailed structures on the boat topside that, by virtue of both their smaller electrical size and geometric complexity, scatter significantly over a broader range of angles, including the backscattering direction. Complicating the situation further, the returns from these detailed features are often significantly influenced through interaction with the large-scale surfaces of the boat. Even though the direct return from these large surfaces may be weak, their indirect return mediated by topside features can be significant.

Ideally, the entire problem would be solved with full-wave methods, which are intrinsically more accurate than asymptotic approximations. However, even with modern algorithmic and hardware accelerations, this is not feasible in the foreseeable future. Given the mixed scale of the problem at X-band and above, what is needed is a combined asymptotic/full-wave (hybrid) technique that exploits the respective strengths of such methods to solve the overall problem. Further, given the electromagnetic interaction between these mixed-scale features, it is important that the solution components be fully coupled.

This hybrid simulation capability should be embodied in a tool that is easy to use, especially in the context of mixing simulation methodologies that may have very different modeling requirements. To be useful, the capability should be efficient, and attention should be given to potential for hardware and algorithmic acceleration, including GPUs and traditional parallelization. The proposer should demonstrate source code ownership of any computational electromagnetics software to be used in this project.

PHASE I: Identify asymptotic and full-wave methods and software that are well suited to their respective large- and small-scale roles in sea-based target signature prediction. Develop and demonstrate feasibility of hybridization algorithms on multi-scale problems, considering their accuracy and practicality for robust implementation. Develop an implementation plan that shows how the mixed-scale hybridization would be configured through a graphical user interface (GUI) in light of the input requirements of the hybrid algorithm(s) and underlying solvers. Utilize any multi-scale problem to demonstrate hybrid approach feasibility for further development and refinement in Phase II.

PHASE II: Further develop and demonstrate the hybridization algorithms initiated in Phase I and implement the hybrid simulation capability in a prototype tool that includes a GUI for problem setup and output visualization. The GUI design should emphasize ease of use in the context of configuring hybridization for multiple large- and small-scale structures, including the surrounding sea state. Identify modeling and GUI improvements needed for commercialization. Identify and pursue initial hardware acceleration, including GPUs and clusters. The Navy will provide concrete and necessary technical parameters, based on current operational scenarios, upon initiation of Phase II proposal development.

PHASE III: Develop a commercial-grade software tool that provides an end-to-end hybrid modeling capability for this and other mixed-scale application areas, including a robust GUI and thorough user documentation. Fully implement hardware acceleration on GPUs and/or clusters.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic provides significant benefits to a variety of commercial and military radar sensing applications of mixed-scale targets, including aviation, boats and ships, spacecraft, ground vehicles, and fixed installations.

REFERENCES:
1. Knott, E.F., Shaeffer, J.F., & Tully, M. T. (2004), Radar Cross Section, 2nd Edition, SciTech Publishing

2. Skolnik, M. (1990). Radar Handbook (2nd ed.). Columbus, OH: McGraw-Hill.

3. Medgyesi-Mitschang, L. N. and D.-S. Wang, "Hybrid methods in computational electromagnetics: a review", Computer Physics Communications, Vol. 68, pp. 76-94, 1991.

4. Jacobus, U. and F. M. Landstorfer, "Improved PO-MM Hybrid Formulation for Scattering from Three-Dimensional Perfectly Conducting Bodies of Arbitrary Shape", IEEE Trans Antennas Propagat, Vol. 43, No. 2, pp. 162-169, 1995.

5. Hodges R. E., and Y. Rahmat-Samii, “An iterative current-based hybrid method for complex structures,” IEEE Trans. Antennas Propagat., vol. 45, no. 2, pp. 265—276, Feb. 1997.

6. Jin, J-M, et al., “A hybrid SBR/MoM technique for analysis of scattering from small protrusions on a large conducting body,” IEEE Trans. Antennas Propagat., vol. 46, no. 9, pp. 1349—1357, Sep. 1998.

KEYWORDS: Computational Electromagnetics, Modeling and Simulation, Hybrid Methods, Small Boat Detection, Small Boat Identification, Small Boat Classification.

N131-004 TITLE: <u>Automated Target Area Threat and Route Optimization</u>

TECHNOLOGY AREAS: Air Platform, Information Systems, Weapons

ACQUISITION PROGRAM: PMA-281

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a tool to automatically optimize multiple disparate platforms' performance, survivability and target area deconfliction in high threat environments.

DESCRIPTION: The Joint Mission Planning System (JMPS) and the Common Control System (CCS) as well as Joint Strike Fighter require a near real-time threat and target area routing and de-confliction capability that optimizes multiple disparate manned and unmanned platforms' performance, increases their survivability and assures probability of kill (Pk) in a high threat environment. The tool should support the benefits of platform survivability enhancements, onboard/offboard jamming, and active and/or responsive Suppression of Enemy Air Defense (SEAD) measures, while minimizing strike platform exposure during the prosecution of a high value target. The tool will be designed and integrated into both the JMPS planning suite and CCS for demonstration and ultimate fielding.

PHASE I: Develop a conceptual software tool to perform the requested functionality with a focus on near real-time performance. Define preliminary performance metrics.

PHASE II: Develop a prototype software tool and perform simulations to demonstrate functionality. Generate detail performance metrics and define integration requirements.

PHASE III: Finalize the design and generate a fully functional software tool ready for integration and operational testing and conduct performance validation and verification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Air traffic control, Ship traffic control, Unmanned Vehicle deconfliction.

REFERENCES:

1. Vincent C. Li, Guy L. Curry, E. Andrew Boyd. Towards the real-time Solution of Strike Force Assets. www.davi.ws/doc/Li-Curry-Boyd.pdf

2. Jieh-Shian Young. Profile Emulations of Target Waypoints for Mission. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=05899114

3. James M. Krause, Tariq Samad, and David Musliner. Multiple Vehicle Mission Management:Coordination and Optimization. http://www.musliner.com/david/papers/nato99.doc

4. P. L. Smith. Air Interdiction Mission Planning using Dynamic Programming. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=04047043

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KEYWORDS: Strike planning; Deconfliction; Survivablility; Joint Strike Fighter (JSF), Unmanned Air Vehicle (UAV), Suppression of Enemy Air Defense (SEAD)

N131-005 TITLE: Advanced Wireless Maintainer Communications in Electromagnetically Noisy Environments

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: JSF-Sus

OBJECTIVE: Develop technology for reliable, high-bandwidth wireless data and voice communications with low probability of intercept that could be used on the ground for maintainers in electromagnetically noisy environments.

DESCRIPTION: Military aircraft platforms can operate from and in highly dynamic environments with many ground personnel performing various tasks, such as ordnance loading, hot fueling, recovery of equipment and personnel, and multiple aircraft launches and in-flight mission operations. Mission success requires a high level of coordination and communication. Current systems for wireless communication around and aboard aircraft platforms have been unreliable and sometimes inadequate due both to susceptibility in high energy electromagnetic environments and to interference with other avionics equipment due to self-generated radio frequesncy (RF) emissions.

An innovative implementation of communications transmission technologies that could provide aircraft maintainers with close to 100 percent reliable wireless voice and data communication with other maintainers and the pilots both while standing near the aircraft and up to a radius as far as 300 feet (~100 meters) for flight line operations is sought. Examples include optical and ultrasonic transmissions, or other methods that will not be susceptible to electromagnetic noise. These technologies should be capable to integrate with existing maintainer radio communications with minimal impact to space and power requirements. Consideration should be given to methods to keep communications to the relevant parties (maintainer to maintainer, maintainer to pilot, etc) without inhibiting effective communications intelligibility of other personnel across the flight line or flight deck environment. Further, integration to aircrew communications headsets and helmets should be possible in order to allow clear communications from the aircraft cockpit without having a maintainer plugged into the aircraft communications system. Future development should allow the technology to extend to all flight deck and flight line maintainers, and eventually to rotary wing and transport aircraft platforms to allow aircrew constant communications with the aircraft communications system even while operating outside the aircraft.

It is important to note that the aircraft operational environments, such as the aircraft carrier flight deck, present considerable challenges. Electromagnetic interference from operating radar is an especially critical problem with existing radio frequency technologies. In addition, proposed solutions should consider other environmental factors of military air operations, both shipboard and ashore, such as temperature extremes, exposure to elements (solar radiation, salt fog, humidity, freezing rain, acidic atmosphere, etc.), and contamination by fluids (jet fuel, hydraulic oil, lubrication oil, solvents, etc).

PHASE I: Provide aconceptual design and determine the feasibility through analysis and/or focused demonstrations. Address cost and performance for the maintainer and in the airframe environment to the maximum extent possible.

PHASE II: Develop a prototype system and demonstrate it in a relevant environment such as the simulated flight deck electromagnetic environment used in MIL-STD-464 testing. Perform ANSI speech intelligibility and attenuation testing on prototypes integrated with maintainer headsets to test plans. Provide an assessment of cost, performance, reliability and supportability.

PHASE III: Further develop a prototype for robustness, shock testing, manufacturability and reliability/maintainability. Qualify it for flight safety. Produce production units and integrate them into targeted maintainer and pilot systems, including interface with known aircraft communications systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The communications industry would benefit from technologies developed under this topic to apply to new concepts in communications transmissions.

REFERENCES:
1. Tanaka, Y, Haruyama, S., & Nakagawa, M. (2000). Wireless optical transmissions with white colored LED for wireless home links. Personal, Indoor and Mobile Radio Communications. PIMRC. The 11th IEEE International Symposium on, vol.2 pp.1325-1329.
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=881634&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D881634

2. 500 Megabits/Second with White LED Light. news release (Siemens). 2010. Retrieved June 28, 2011.
http://www.siemens.com/innovation/en/news/2010/500-megabits-second-with-white-led-light.htm

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5. American National Standards Institute (ANSI) S3.2-2009, Method for Measuring the Intelligibility of Speech over Communications Systems. http://webstore.ansi.org/

6. American National Standards Institute (ANSI) S12.6-2008, Methods for Measuring the Real-Ear Attenuation of Hearing Protectors. http://webstore.ansi.org/

KEYWORDS: Wireless; communications; Optical; Warfighter Personal Protection; Ultrasonic; Maintainer

N131-006 TITLE: Direct Digital Radio Frequency (RF) Conversion Digital Radio Frequency Memory (DRFM)

TECHNOLOGY AREAS: Air Platform, Information Systems, Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMA-272

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop an advanced all digital Electronic Attack (EA) Digital Radio Frequency Memory (DRFM) system minimizing Radio Frequency (RF) component technology that will reduce size/cost/complexity and increase capability and effectiveness through wider bandwidth.

DESCRIPTION: Recent advancements in high speed signal processing technology offer the possibility for significant efficiency of EA DRFM systems. Direct Digital conversion of RF signals has the potential to reduce DRFM size, power consumption, and unit cost.

Typical DRFM technology utilize an RF translation to baseband, Radio Frequency (RF) sampling, storing digitized samples into memory and then reversing the process to reconstruct the RF signal prior to transmission to the victim radar. This allows for both time domain and frequency domain manipulation of the radar signal. The Direct Digital RF Conversion DRFM would eliminate the RF signal translation modules of conventional architectures. In addition, this will reduce size and power requirements by significant margins. The per unit price reduction would allow for multiple parallel DRFM architectures capable of simulating emerging threat DRFM systems that threatens US radar systems.

The goal of the project is to develop a DRFM architecture utilizing direct RF to digital conversion to simultaneously respond to multiple radars across a broad spectrum of RF frequencies. The innovative aspect is to advance direct RF to digital conversion technology to simultaneously cover more than three (3) octaves of frequency while minimizing spurious harmonics and RF through put delay.

Improvements and design advancements resulting from successful execution of this project will result in: A simplified DRFM design; reduced unit cost (target 40%); increased reliability (increase by a factor of 10), capability (2-18 GHz in a single miniaturized platform) and effectiveness (Multiple radar responses in a miniaturized platform); reduced size - UAV/subscale drone applications (Projected size reduction of 35%); reduced prime power requirement (Projected power reduction of 40%); and allow for multiple parallel DRFM chip sets that would follow advancing threat DRFM capabilities against new US radar systems. In addition, this would provide a test asset for the development and testing of radar electronic protection systems.

Currently fielded DRFM systems built by commercial vendors, such as KOR Electronics, build airborne DRFM systems that cover at most only 1.4 GHz of instantaneous bandwidth. The size of these systems are 11” x 6.5” x 4.75” and the units can draw as much as 125 Watts of power.

PHASE I: Determine the feasibility for sampling and digitizing the signal directly at microwave frequencies. Determine the feasibility for digitally reconstructing the signal at microwave frequencies and add digital deceptive modulation techniques. Develop a system design approach and establish the associated requirements for implementing a lab bench prototype for testing in a Phase II effort. Generate a cost analysis detailing how direct digital conversion technology may reduce costs to produce and maintain these DRFM systems.

PHASE II: Develop and build a lab bench prototype Direct Digital RF Conversion DRFM. Perform bench tests in order to demonstrate/validate the fundamental digital technology versus present day analog technology.

PHASE III: Finalize and build a flight capable production prototype and perform airborne tests in order to validate the technology in an actual environment. Transition the technology to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential Dual Use in support of both DoD and Homeland Security. This project will provide a self-protect jamming capability for use on airborne platforms.

REFERENCES:
1. Stearns S.D. & Hush D.R., (1990). Digital Signal Analysis (2nd Ed.). Prentice Hall

2. Parssinen A, (2010). Direct Conversion Receivers in Wide Band Systems (The Springer International Series in Engineering and Computer Science). Springer

3. KOR Electronics website. http://www.korelectronics.com/products/drfm/

KEYWORDS: DRFM; sampling and digitizing; digital deceptive modulation techniques; direct microwave to digital conversion; electronic protection; electronic attack.

N131-007 TITLE: High Gain Common Data Link (CDL) Antennas for Networking UAV Nodes

TECHNOLOGY AREAS: Air Platform, Battlespace

ACQUISITION PROGRAM: PMA-266

OBJECTIVE: Enable the Fire Scout to operate as a node in a high-speed mobile star network.

DESCRIPTION: The Unmanned Air Vehicle (UAV) could increase its utility to the fleet by operating as a node in an airborne star network. Current Tactical Common Data Link (TCDL) antenna availability and positioning on the airframe do not allow TCDL Omni-directional, simultaneous multi-channel communications. Ideally, the UAV should be able to support 6 high-speed channels operating at 200Kbps, 2Mbps, 10.71Mbps and 21.42Mbps. This enabler is to support full-two way communication with up to six other nodes for transfer and relay of data, imagery, command and control with 360 degree coverage, within a 110NM UAV slant range.

Current TCDL antenna technology does not support simultaneous multi-channel communications capability. The TCDL Omni-directional antennas lack the gain and simultaneous multi-channel bi-directional communications. The TCDL directional antennas don’t support the high-speed multi-point distribution needed. Several possible solutions have been ground tested for other situations, including multiple beam antennas and phased array antennas, with no known solutions. Significant issues with size, weight and power must be overcome to make any solution viable for a small platform such as Fire Scout.

The High Gain Common Data Link (CDL) Antennas for Networking UAV Nodes will be able to provide 360 degrees TCDL networked communication links which allow a single star network distribution and static or dynamic Internet Protocol address routing table for 6 high-speed simultaneous channels. The deliverable will be a combination of hardware (antennas, connectors, routers, transponders, etc.) and software (network switching).

ForceNet and Gap FY14-23 require network-enabled UASs capable of creating mobile networks. The VTUAV currently cannot support network connectivity due to its TCDL directional antennas, such as the Fire Scout operates at a return link rate of 10.71 Mbps at 110 nautical miles. This data rate and range cannot be supported using TCDL Omni-directional antennas. The current TCDL Omni-directional antenna lacks sufficient gain to allow operations at the required ranges. To be useful in supporting the network (transmitting CDL at 21.42 Mbps to/from the number of six nodes) the UAV will need to support up to137 Megabits per second data rates, using improved specialized antennas at a range of up to 110 nautical miles.

For example, the Fire Scout TCDL antennas currently support 10.71 Mb/s downlink rates for imagery transfer, voice and aircraft status, and 200 kb/s uplink rates for Command and Control (C2). At 137Mbps, the Fire Scout would be able to support full-two way communication with up to six other nodes for transfer of data, imagery and command and control with this High Gain Common Data Link (CDL) Antennas for Networking UAV Nodes.

PHASE I: Develop and prove feasibility of a solution to provide a capability for unmanned vehicles to operate as a high-speed node in a mobile star network with up to six nodes.

PHASE II: Develop and deliver a prototype that includes the hardware and software to deliver multimode, high-speed mobile star network service.

PHASE III: Finalize the solution and perform testing and transition to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The product would have use in a variety of homeland security areas such as border patrol and the Coast Guard.

REFERENCES:
1. L-3 Communications. Rover 5 Handheld. http://www2.l-3com.com/csw/ProductsAndServices/DataSheets/ROVER_5_WEB.pdf

2. USMC Team Portable CDL (TP-CDL), 2009. http://www.marcorsyscom.usmc.mil/sites/cins/INTEL/RAPID%20PROTOTYPING%20TEAM/TP-CDL.html

KEYWORDS: Algorithms; antennas; networking; TCDL; multichannel communications; omnidirectional coverage

N131-008 TITLE: Graphics Processing Unit (GPU) Acceleration for Cosite Interference Prediction Tools

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA-264

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Port existing electromagnetic interference and vulnerability (EMI/EMV) simulation tools to the latest technology computer clusters in order to significantly reduce the time required for analyzing cosite interference on complex platforms.

DESCRIPTION: Modern aircraft present very complex environments carrying a large number of radio frequency (RF) systems and their associated antennas. These RF systems must all function properly in operational environments without causing interference to each other (i.e., cosite interference). The operational requirements of these systems can vary depending on mission requirements and timeline. Operational frequencies (including frequency hopping) and other operating parameters of the RF systems can vary, and different RF systems may be required to operate simultaneously and in different configurations of the aircraft. To insure mission success, all possible configurations must be evaluated and any interference mitigated prior to fielding the aircraft. The goal of EMI/EMV prediction tools is to allow analysts to accurately predict RF system level performance degradation in these types of complex environments and to explore mitigation methodologies to eliminate any cosite interference. These simulations can be very time consuming due to the large number of potential permutations of operational parameters and configurations that need to be considered for a complete analysis, and this is exacerbated by the added computational burden of including the non-linear aspects of the problem that often represent important interference mechanisms.

Advances in computer architecture over the past decade have greatly reduced the cost of computational hardware required for computational simulations. The goal of this project is to develop new analysis algorithms that can take advantage of parallelization on modern computational hardware to improve execution time by orders of magnitude, thus reducing the time required for a complete cosite interference analysis. The hardware for such an effort can be a traditional central processing unit (CPU) cluster or a graphics processing unit (GPU) cluster [1]. GPU-based development has moved into the mainstream due to the maturity of GPU programming languages such as CUDA [2] and OpenCL [3] and researchers are using GPU clusters for a variety of simulation problems [4]. With the above in mind, we are seeking innovative solutions for developing EMI/EMV simulation algorithms for cosite interference prediction on both CPU and GPU-based parallel environments for the purpose of greatly accelerating their performance. Small businesses must clearly demonstrate the capabilities of their simulation tool and its effectiveness in predicting cosite interference in their proposal. They should also have an understanding of GPUs and OpenCL or CUDA and be prepared to work in both a CPU and a GPU environment. Previous experience in programming GPUs is highly desirable. Prime should have property rights to the source code of the EMI/EMV simulation tool.

PHASE I: Investigate the key computational algorithms found in EMI/EMV simulation tools in order to determine the potential benefits of different forms of hardware parallelization. Identify EMI/EMV algorithms that may be problematic in transferring to a parallel environment and develop modifications. Research new algorithms that can provide higher-fidelity solutions than existing technology, and if feasible, develop prototypes to measure their effectiveness. Explore other hardware acceleration techniques that could potentially be developed during the Phase II effort in order to improve the accuracy or computational performance of EMI/EMV simulations. Develop a Phase II implementation plan for a hardware accelerated version of the software.

PHASE II: Execute the implementation plan created in Phase I to develop the hardware-accelerated EMI/EMV software algorithms and build a commercially mature software tool. Port the new EMI/EMV software tool to the project sponsor's cluster environment. Validate the successful implementation of the parallelization through timing and accuracy studies using realistically complex aircraft environments. Ensure that the resulting algorithms are scalable with increasing number of processors. Deliver, install, and provide training for the parallelized EMI/EMV simulation software to NAVAIR along with thorough documentation. If NAVAIR is interested in other hardware acceleration techniques identified during Phase I, implement prototype capabilities during the Phase II effort.

PHASE III: Refine the methodology and tool developed in Phase II and expand its predictive capabilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic can be used in the commercial communications industry, including platform integration, electromagnetic compatibility (EMC) and electromagnetic interference (EMI) and antenna placement.

REFERENCES:

1. What is GPGPU? http://www.gpgpu.org/

2. GPU Computing: The Revolution. http://www.nvidia.com/object/cuda_home.html

3. OpenCL - The open standard for parallel programming of heterogeneous systems. http://www.khronos.org/opencl/

4. Z. Fan, F. Qiu, A. Kaufman, & S. Yoakum-Stover (2004). GPU Cluster for High Performance Computing. In Proc. of the 2004 ACM/IEEE Conf. on Supercomputing (SC '04). IEEE Computer Society, Washington, DC, USA, 47

KEYWORDS: electromagnetic interference and vulnerability (EMI/EMV), electromagnetic, cosite interference, computer clusters, computer GPUs, hardware acceleration

N131-009 TITLE: Low Size Weight and Power (SWaP) wideband Digital Receiver Exciters (DREX) technologies for Radar and Communication Systems

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMA 290

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop innovative low size, weight and power (SWaP) wideband Digital Receiver Exciter (DREX) technologies for application to next generation Navy Radar and Communication Systems.

DESCRIPTION: Next Generation Radar and Communication Systems are required to be low SWaP yet have flexibility via highly digitized DREXs that support high-bandwidth advanced waveforms and high bandwidths for relatively large arrays, Digital Beam-Forming (DBF), Space-Time Adaptive Processing (STAP), and Multiple-Input Multiple-Output (MIMO) Radar and dual use Radar/Communication applications. In addition, additional total system SWaP improvements can be obtained by performing additional applicable signal processing in the DREX, thus simplifying the interface of the antenna sub-system to the general purpose signal processor. Low SWaP DREX architectures will require to be highly integrated with the array and the application. In addition, practical hardware channels are not perfectly matched in phase and amplitude response requiring the DREX to perform the channel-to-channel matching and equalization.

The goal of this SBIR is to develop low SWaP DREX techniques that integrate closely to radar and communication phased array systems that lower the total system SWaP and cost.

Innovative and integrated low SWaP DREX technology enables thin, efficient, low SWaP, low cost, high performance radar and communication phased array systems. These arrays would eliminate the need for mechanical gimbal positioners by placing the antennas on all sides of the platform for complete 360 degree field of view (FOV) entirely electronically scanned. With small arrays then even full duplex high bit rate communication could be easily done.

The concepts for radar and communication array should span frequencies from 2 to 17 Ghz and support bandwidths up to 1 GHz. The concepts should consider both high bit rate digital two way communication and radar search and track functions. Design should consider the needs in the antenna section and applications for both communication and radar. There should be as much commonality in design as possible to implement communication and radar in the same AESA.

PHASE I: Develop and determine the feasibility of DREX concepts for radar and communication array. Select a frequency band and design concept for Phase II implementation to prove the concept.

PHASE II: Perform the detail design of low SWaP DREX to be integrated with a phased array antenna and ready it for full implementation in Phase III. Demonstrate the prototype and produce specifications and detail designs to support fabrication.

PHASE III: Build one or more DREX for integration on radar and/or communication systems for proof demonstration eventual transition to selected platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed technology has a number of related commercial applications in communication and radio frequency (RF) sensors such as radars. Commercial radar systems, commercial and communications systems (e.g. Telecom, SATcom), all require DREX and have increasing needs for wideband low power, highly digital (flexible) DREX technology.

REFERENCES:
1. Hao H., Stoica, P. & Jian L. (2010). Waveform design with stopband and correlation constraints for cognitive radar. Second International Workshop on Cognitive Information Processing (CIP).

2. Krieger, G., Gebert, N. & Moreira, A. (2008). Multidimensional Waveform Encoding: A New Digital Beamforming Technique for Synthetic Aperture Radar Remote Sensing. IEEE Transactions on Geoscience and Remote Sensing, 46,1.

3. Krieger, G., Gebert, N. & Moreira, A. (2008). Digital Beamforming Technique for Synthetic Aperture Radar Remote Sensing. IEEE Transactions on Geoscience and Remote Sensing. 46,1.

KEYWORDS: Radar; Digitial Receiver; Digital Beam-Forming; Space-Time Adaptive Processing; Multiple-Input Multiple-Output; Communication

N131-010 TITLE: Optical Inertial Reference Unit for Navy Tactical Airborne High Energy Laser (HEL) Applications

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PMA-265

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and fabricate a compact optical inertial reference unit (IRU) for operation suitable for High Energy Laser (HEL) Weapon systems on tactical air platforms.

DESCRIPTION: Recent developments in subsystem performance have made realistic the potential for the incorporation of high energy lasers (HEL) on tactical aircraft. The volume and weight restrictions of air platforms as well as performance requirements have placed serious constraints on the overall system. The dynamic scenarios for tactical aircraft are challenging from the standpoint of absolute knowledge of platform position and orientation (for predictive avoidance and target acquisition and de-confliction), as well as line of sight stabilization in the high vibration environment in which the HEL must operate. Ideally, one IRU could fulfill both roles, having low drift, for precise attitude determination, and good high frequency characteristics, along with a guide beam to mitigate optical train jitter. If not quantified, the resulting LOS jitter can increase noise in target state estimates, leading to more jitter and decreased track continuity.

The specific constraint of the platform environment requires component precision alignment as one of the most critical requirements for a laser weapon system which leads to aim point maintenance/jitter rejection. An Optical Inertial Reference Unit forms the core of jitter rejection concepts in high energy laser and other precision optical systems. Generally each application and platform brings its own requirements and thus suggests a unique design, or at least a modification of existing designs. The focus of this solicitation is for an optical IRU that can address the requirements of multiple platform-based high energy laser systems, such as the F/A-18 and MH-60S. These requirements include:

• Small package on the order of 2”x2”x2” cube for electronics and sensor able to be remotely mounted
• 2 milliradian of throw between the stable platform and the base and provide at least 1 micro-radian precision relative position feedback to the optical gimbal control system
• Laser source having user-selectable wavelength and a 2-3 mm reference beam
• Capable of handling slew rates of at least 2 rad/s
• Stable element rate loop bandwidth minimum of 100 Hz for 50 micro-radian commands
• Residual jitter on the alignment beam of < 1 micro-radian per axis RMS from 1 Hz to 1 kHz in a quiescent specified base motion environment
• > 40 dB of angular base disturbance rejection at all frequencies between 1 Hz and 1 kHz, with > 60 dB rejection at and below both 1 Hz and at and above 1 kHz
• Isolation to produce minimal coupling of linear vibration into residual angular motion of the reference beam

NAVAIR is seeking innovative ways to improve IRU performance in a reduced size. Although specifically targeted for implementation in future high energy laser systems for tactical air platforms, the same technology would undoubtedly provide benefits to ground and sea based high energy lasers and programs in all the services for applications such as target designation, laser radar and laser countermeasure systems. Current systems under development that would benefit include DoD HEL Weapons and Marine/Army ground designation devices. The target of this program will be to demonstrate a rejection of the platform vibration induced HEL jitter to < 1 micro-radian per axis RMs for a platform such as the F/A-18 mounted in a pod in a compact device ~ 2 inch cube. Operation in a military environment will be essential for future applications; therefore the IRU must survive the shock, vibration, and temperature environments of a deployed device. Finally, the resultant IRU must be designed in a way as to be consistent with current state-of-the-art high volume manufacturing practices in the industry (i.e., cost competitive on a $/rejected jitter basis with current technology). The goal for the end of the program would be to achieve a per unit cost of < $120,000.

PHASE I: Develop a conceptual design for compact optical inertial reference unit that meets Navy requirements. Include methodology and prototype performance that will demonstrate the proposed concept at the performance above.

PHASE II: Develop detailed designs for the Phase I compact optical inertial reference unit and fabricate a limited number of IRU's suitable for proof of concept testing. Conduct preliminary testing.

PHASE III: Scale up for mass production of the IRU. Transition into various laser weapon programs on multiple air platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial use is in for lasers systems that operate in a rugged environment where component alignment is critical to system operation. These include precision pointing systems such as required for laser communication.

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1. Perram, G.P. et.al. (2010). Introduction to Laser Weapon Systems. Air Force Institute of Technology. Directed Energy Professional Society, Albuquerque, NM.
http://www.deps.org/store/merchandise/TOCs/IntroLaserWeaponsTOC.html

2. Merritt, P. (2011). Beam Control for Laser Systems. Directed Energy Professional Society, Albuquerque, NM.
http://www.deps.org/store/merchandise/TOCs/BeamControlLaserSystemsTOC.html

KEYWORDS: Jitter Control; High Energy Laser Weapons; Beam Control; Precision Optical Systems

N131-011 TITLE: Energy Harvesting, Wireless Structural Health Monitoring System for Helicopter Rotors

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA-261

OBJECTIVE: Provide a novel low weight, high-speed structural health monitoring (SHM) system, capable of transferring health and usage sensor data (e.g. pressure, strain, vibrations, temperature) from the rotating frame to a base station unit in the non-rotating frame via wireless transmission.

DESCRIPTION: Health and Usage Monitoring Systems (HUMS) have been developed and implemented for both commercial and military helicopters, the latter group including platforms such as the H-60, H-1, H-53, and V-22. Onboard HUMS enable the realization of Condition Based Maintenance (CBM), a set of maintenance processes and capabilities that are derived from real time or near real time assessment of system condition from onboard embedded sensors. Current HUMS technologies require direct connection for data acquisition from sensors. To transmit data from the rotating system down to the non-rotating system, a device known as a slip ring is used. The slip ring assembly allows the wiring from the rotating system to rotate without tangling or interfering with one another by ensuring a continuous electrical connection between a series of sliding brushes and the conductive housing. As the number of rotor mounted sensors increases, the weight of the slip ring assembly can range from 6.5 lbs to 15 lbs, making this approach undesirable. Also, fiber optic sensors currently require significant amounts of power to acquire data at acceptable sampling rates; therefore the SHM unit must be able to harvest sufficient energy to support a distributed fiber optic network. Significant challenges for data acquisition include a periodically obstructed transmission path, multi-path reflections, Doppler shifts of signal, and electromagnetic radiation interference from other electronic equipment on the aircraft and ship. Despite the advances in local sensor technology such as miniaturization, energy harvesting, and local data processing, methods for transferring the sensor data from the rotor system down to the fuselage are stagnant.

The low-weight, high-speed SHM system should be capable of transferring health and usage sensor data from the rotor blades to a base station unit in the non-rotating frame via wireless transmission. This data would provide engineers with cycle-by-cycle loading histories in the blades, allowing for more accurate fatigue life assessment. The sample data rates shall be programmable depending on the data source, ranging from 10-5000 Hz, for customizable use. Sampling rates should be a minimum of 5x the maximum input signal frequency of interest. The system must optimize use of materials and electronics to achieve a low weight, not to exceed 2 pounds. Also, these blade sensors would be able to detect the onset of significant structural damage, and the growth of such damage under continued operation. The robustness of fiber optic sensors has been tested in harsh environmental conditions such as wind and engine turbines, which makes it a suitable technology for use in helicopter rotor blades.

PHASE I: Develop a novel approach for a reliable, low-weight, SHM system described above with wireless communication between rotating and stationary frames of reference. Demonstrate the feasibility of this approach by bench testing in a lab environment.

PHASE II: Build a prototype based upon the Phase l approach. Evaluate data quality and accuracy of the prototype by transferring sensor data in parallel through a conventional slip ring during a helicopter flight test. Develop a plan for full system airworthiness qualification onboard a Navy/Marine helicopter, including environmental, vibration, and shock per MIL-STD-810, electromagnetic environmental effects (E3) per MIL-STD-464, and electromagnetic interference (EMI) per MIL-STD-461.

PHASE III: Perform full system airworthiness qualification onboard a Navy/Marine helicopter, including environmental, vibration, and shock per MIL-STD-810, electromagnetic environmental effects (E3) per MIL-STD-464, and electromagnetic interference (EMI) per MIL-STD-461. Evaluate qualification test results and provide procurement specification for transition to an actual production platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The results of this SBIR effort can be commercialized through the major helicopter OEMs for the private sector market. This type of data system could lead to an automated track and balance system that could drastically improve the vibration environment in both military and commercial helicopters. Additional applications include automotive tire condition monitoring, wind turbines, and leak/damage detection along oil/gas pipelines where the transmission path of mechanical health data is not constant. This technology could also benefit industrial applications which use conventional slip rings such as: measurement and testing, robotics and turntables for packaging, bottling, and tooling/inspection machines.

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7. MIL-STD-810. Environmental Engineering Considerations and Laboratory Tests. Revision G, 31 October 2008. http://www.everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL_STD_810F_949/

8. MIL-STD-464. Electromagnetic Environmental Effects Requirements for Systems. Revision C, 1 December, 2010. http://www.everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-464C_28312/

9. MIL-STD-461. Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. Revision F, 10 December 2007. http://www.everyspec.com/MIL-STD/MIL-STD-0300-0499/MIL-STD-461_8678/

KEYWORDS: Wireless; Energy harvesting; HUMS; CBM; slip ring; fiber-optic

N131-012 TITLE: Earplug-Integrated Miniature Wireless Sensors for Warfighter Monitoring and Earplug Evaluations

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

ACQUISITION PROGRAM: JSF-Sus

OBJECTIVE: Develop miniature wireless sensors that can be integrated into commercial off-the-shelf (COTS) earplugs, without interfering with earplug properties, for evaluation of earplug performance and for continuous monitoring of warfighter physiological status during military operations.

DESCRIPTION: Warfighters require hearing protection to reduce their exposure to potentially damaging noise levels in the combat environment. Earplugs used by warfighters range from classic passive foam earplugs to custom-molded earplugs with integrated communications. There is a need to objectively measure earplug performance and safety, but is currently difficult to obtain these measurements because no sensors exist that can measure the area of interest, the space in the ear canal between the end of an inserted earplug and the eardrum, without compromising the performance of the earplug. In addition, although sensors have been successfully integrated into specially designed earplugs for applications such as measuring noise exposure, head accelerations, and heat stress, these sensors are not designed for use with commercial off-the-shelf (COTs) earplugs. Recent advances in technology have facilitated the creation of miniaturized and micro sensors, which are currently used in several areas including medicine, research, and manufacturing. There have also been advances in wireless data transmission, such as radio-frequency identification (RFID), which can be combined with sensors for miniature and micro-scale applications.

A new type of miniature wireless sensor is needed that is small enough to fit on the end of an earplug, does not interfere with earplug properties, and is safe for human use. Earplug-integrated wireless miniature sensors for personnel monitoring would benefit warfighters by increasing mission effectiveness and safety by providing objective measurements that could be used to evaluate the performance and safety of current and future COTS earplugs and for continuous monitoring of the physiological status of a warfighter during military operations.

One area of particular interest would be monitoring pressure within the ear canal for military pilots and aircrew personnel wearing earplugs. The Navy and Air Force have approved only vented versions of communications earplugs for jet pilot and aircrew use following a 2004 incident of otitic barotrauma (eardrum rupture) in a pilot who was wearing custom molded communications earplugs. The requirement for venting was based on safety concerns and the belief that non-vented versions of these devices can prevent pressure equalization of the “trapped volume” between the earplug and the eardrum during altitude changes, leading to eardrum rupture. Earplug-integrated pressure sensors could be used for evaluating the pressure equalization capability of earplugs in order to determine their safety for pilot use.

Miniature sensors could have many other uses as well. Miniature microphones integrated into earplugs could allow for objective evaluation of attenuation in real-world settings in order to determine the best earplugs for specific applications, to calculate allowable noise exposures for a specific earplug, and to measure real-time noise exposures as part of a hearing conservation program in order to determine when a warfighter meets their daily noise exposure limit. Miniature sensors could also be used for continuous monitoring of warfighter physiological status (e.g. blood pressure, temperature, heart rate, blood oxygenation, and stress).

The miniature wireless sensors for earplugs should be durable for repeated use, but cost effective so that they may be replaced if damaged. Sensors must be mountable on several types of earplugs, including foam earplugs, custom molded earplugs, flange earplugs, and communications earplugs. The sensors must be able to be calibrated before tests and readily connected to a portable data acquisition system. The sensors should be easy to attach to earplugs. The correct response of the sensors should be validated through computational modeling or experimental testing.

Technology developed under this SBIR will require Human Testing and proper approvals will be required prior to the award of a Phase II contract.

PHASE I: Design wireless pressure sensors for use with readily available commercial off-the-shelf earplugs. Demonstrate proof of concept of critical features of the design through computational modeling or experimental testing . Develop integration and calibration methods, and cost estimates.

PHASE II: Develop and produce prototype wireless pressure sensors and validate their performance with several types of COTS earplugs (foam, flange, custom-molded) in mannequin and human subjects. Expand upon and investigate the concept of miniaturized wireless sensors beyond pressure monitoring to cover other forms of personnel monitoring that could be done via the ear. Develop life-cycle cost and supportability estimates of such sensors.

PHASE III: Transition technology into production via sales to the Department of Defense and also through commercial sales.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Wireless earplug sensors and the data obtained from them would be invaluable to both military and civilian communities that seek methods to monitor personnel in the field and evaluate real-world performance and safety of COTS earplugs. Further development in miniaturized wireless pressure and other sensors (microphones; sensors for blood pressure, temperature, heart rate, blood oxygenation, stress, etc.) would have many applications in numerous different industries in the civilian sector.

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KEYWORDS: Wireless; Sensor; earplug; hearing protection; monitoring

N131-013 TITLE: Detection and Evaluation of Incipient Composite Heat Damage

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors

ACQUISITION PROGRAM: JSF-AV

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Design and develop an on-aircraft method or tool to identify and evaluate incipient heat damage in advanced composite material systems.

DESCRIPTION: The need to detect and evaluate incipient composite degradation and to understand the effects on airframe viability is critical to both weapon system operating costs and mission safety. The increased use of advanced composites in the structural makeup of naval aircraft directly raises the probability of overheating those materials. Common overheating events include exhaust impingement, extended afterburner usage, repair induced overheating and chemical fire. Unidentified heat damage can result in losses due to both omission and commission. Millions of dollars in replacement parts are lost and mission availability can be degraded if parts are scrapped unnecessarily. Conversely, if damaged parts are permitted to fly the risk to personnel, weapons systems and overall mission success becomes significant.

Currently there is no standard and accepted non-destructive inspection (NDI) technique for fully identifying the extent of heat damage to composite materials caused by heat damage. While damaged paint, charred surfaces and disbonds are readily identified by current NDI techniques, non-visually apparent damage is currently difficult to identify and impossible to quantify.

The ideal system would non-destructively examine a composite part in-situ and determine not only if incipient heat damage exists but also the extent of that damage and its impact to the part. This innovation would determine bulk property loss through part sections or provide surface condition information suitable for ply-by-ply review. Both clean, resin rich areas and sanded surfaces should be capable of interrogation with the novel technology. Evaluation through paint/coatings is a valuable additional feature.

A novel inspection technology is sought that can demonstrate correlation between non-visible heat damage, material property degradation and system response. The long term goal for this program includes the ability to provide on-aircraft evaluation, the target technology should be easily calibrated, robust enough for Fleet Readiness Center (FRC) or shipboard use and readily producible. Different responses would be expected for different material systems. The ideal technology would be adaptable for use with multiple composite material systems.

PHASE I: Design, develop and determine the technical feasibility of an on-aircraft method or tool to determine the extent and resulting structural degradation of composite material parts subject to incipient heat damage. Demonstrate correlation capability suitable for use in structural evaluation of damaged material. Initial material system should be BMI based with expansion possible to epoxy systems.

PHASE II: Produce and demonstrate prototype hand-held Heat Damage Detection & Evaluation Unit (HDDEU) capable of reliably determining the area affected by heat damage and the resultant property degradation on a variety of resin/fiber systems based on results of Phase I.

PHASE III: Finalize HDDEU to be easily calibrated, robust enough for FRC/Shipboard use and readily producible. Transition HDDEU to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Results of this SBIR can be commercialized through the major aerospace and aviation OEMs for the private sector market. HDDEU should be transitioned to a production model suitable for commercial sale.

REFERENCES:
1. Sathish, S., Welter, J., Reibel, R. & Buynak, C. (2005). Thermo-Elastic Characterization of Heat Damage in Carbon Fiber Epoxy Composites. AIP Conference Proceedings, Vol 820. http://proceedings.aip.org/resource/2/apcpcs/820/1/1015_1?isAuthorized=no

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KEYWORDS: NDI; Composite; High Temperature; Heat Damage; Sustainment; Repair

N131-014 TITLE: <u>Efficient Cargo and Personnel Handling System</u>

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA-231

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and demonstrate an efficient cargo and personnel handling system that requires minimal labor effort by the crew to operate.

DESCRIPTION: Aircraft cargo and personnel handling systems have traditionally utilized a combination of roller rails on the floor and troop seats mounted along the wall facing inward. However, traditional cargo and personnel handling systems are not capable of supporting carrier borne cargo aircraft during catapults and traps.

The cargo and personnel handling system in the C-2 Greyhound is functionally behind most cargo capable aircraft in the US military. The current cargo and personnel handling system utilized on the C-2 requires enormous manpower efforts to load and unload the rear of the aircraft. In addition to the structural requirements of the seat, side facing wall mounted seats would not allow the C-2 to transport 28 passengers, thus the seats face rearward and cargo loads forward of passengers. Depending on the size of cargo, passenger seating must be removed and lifted out of the way in order to load the aircraft and then reinstalled to load passengers. Except for extremely heavy packages, all packages are hand carried into the aircraft, which has resulted in numerous back injuries.

An innovative, efficient cargo and personnel handling system that minimizes crew labor effort, improves crew member safety, and reduces time required onboard carriers is sought. The cargo and personnel system approach shall be capable of carrier take-offs and landings. Increasing the C-2 handling system functionality will improve C-2 mission capabilities and bring carrier aircraft capabilities on par to the land based and rotary wing cargo and personnel aircraft.

PHASE I: Develop an innovative approach for cargo and personnel handling system that requires minimal labor effort by the crew to operate. The cargo and personnel system approach shall be capable of carrier take-offs and landings and not reduce current aircraft capabilities. Demonstrate the feasibility of applying the developed approach in a laboratory environment.

PHASE II: Finalize solution and demonstrate practical implementation of a production scalable prototype cargo and personnel handling system. Evaluate the prototype system through demonstration testing on the replica of a military aircraft cargo compartment.

PHASE III: Transition the approach to the fleet and other candidate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An innovative and more efficient cargo and personnel handling system capable of carrier operations can be transitioned into other nations airframes or be utilized in future design ideas, which will improve capabilities, safety, and reliability.

REFERENCES:

1. MIL-STD 1791, Designing for Internal Aerial Delivery in Fixed Wing Aircraft

2. SD-551-1-3 Rev 1, Detail Specification for C-2A Procurement of COD Aircraft

KEYWORDS: safety; Survivability; Cargo; Personnel; Seats; Efficency

N131-015 TITLE: Fiber Optic Bi-Directional Amplifying Repeater

TECHNOLOGY AREAS: Air Platform, Information Systems, Electronics

ACQUISITION PROGRAM: PMA-234

OBJECTIVE: To create a fiber optic amplifying bi-directional repeater to boost optical (digital) signals bound for hardpoint pylons.

DESCRIPTION: The optical power loss budget on military aircraft is demanding. Depending on system criticality and necessary confidence level, the budget only allows for a few connectors between the transmitter and receiver (ref 1). For a fiber optic link to connect the aircraft network to an external pod through a pylon, a fiber optic repeater with amplification is needed.

An innovative solutionis required to develop a repeater capable of meeting or exceeding the following parameters:

Input sensitivity: 0 dBm to -20 dBm
Output Power: > 3 dBm
Wavelength: 850 nm
Fiber: Threshold: 100/140 um, Objective: Include 50/125um and 62.5/125um support
Termini: Threshold: 29504 /4 & /5, Objective: Include NGCON support
Data Rate: Threshold: 1 Gbps Fibre Channel, Objective: 10 Gbps Fiber Channel and Ethernet
Operating Temperature: Threshold: -40C to 100C, Objective: -55C to 125C
Shock: refer to Method 516 in MIL-STD 810G (ref 2) with effective shock duration of 23 ms at 20g
Vibration: refer to table 514.6C-VII in Method 514, MIL-STD-810G (ref 2) under General Exposure

PHASE I: Develop an innovative fiber optic repeater concept based on meeting or exceeding all requirements presented. Demonstrate the feasibility of the concept via modeling and simulation. Demonstrate operation of a benchtop version of the repeater.

PHASE II: Develop and demonstrate operation of a prototype packaged version of the repeater over -40oC to 100oC temperature range. Optimize repeater to meet or exceed all requirements.

PHASE III: Conduct environmental testing for fiber optic repeater. Develop plan for manufacturability and transition of device.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This device would be of value to any application requiring low size, weight and power. Also of note is its ability to function in harsh requirements.

REFERENCES:
1. SAE AS5750 - Loss Budget Specification for Fiber Optic Links, Jan 2009

2. MIL-STD-810G - Environmental Engineering Considerations and Laboratory Tests, Oct 2008

KEYWORDS: Fiber optic; repeater; amplifier; pylon

N131-016 TITLE: Life Improvement of Plain Airframe Bearings by Preventing Contamination

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-275

OBJECTIVE: Develop a low cost, low friction innovative contamination prevention system for plain airframe bearings.

DESCRIPTION: Plain lined spherical bearings are used in a variety of aerospace applications to provide a connection between two structures experiencing oscillating and misaligning motions. Liquid and solid contamination is a common issue that significantly diminishes the operational life of the bearing. As normal liner wear progresses, the bearing becomes even more susceptible to contamination due to an increased gap for contamination to penetrate the liner/race interface. The presence of both solid and liquid contamination in the bearing exacerbates the wear rate, resulting in premature plain bearing degradation and failure.

Current contamination prevention methods increase friction which generates heat further contributing to bearing failure or performance limitations. Bearing shields are expensive and do not provide acceptable protection to justify their expense. Bearing contamination impacts every aircraft in the fleet and therefore causes excessive maintenance costs and operational availability.

A low cost, low friction solution to prevent contamination of plain airframe bearings is sought. The proposed solution will consider both material selection and design features to achieve high contamination resistance while minimizing additional friction and cost. The proposed system would increase bearing life by protecting the bearing without significantly increasing initial breakaway/running torque, temperature or maintenance cost. Additional bearing installation time, methods and equipment should be minimized.

The proposed design would need to support a universal system integration including all SAE Aerospace standard bearings (AS81819, AS81820, AS81935, AS82819 and AS8942) for all sizes and material options.

PHASE I: Develop innovative concepts for preventing contamination in plain airframe bearings. Demonstrate the feasibility of the approach through limited testing.

PHASE II: Fully develop the concept conceived during Phase I into a prototype bearing contamination prevention system. Demonstrate the ability of a protected bearing assembly to withstand the severe Navy environment while performing limited qualification testing.

PHASE III: Complete all required qualification testing to implement the technology. Develop low cost manufacturing approaches and transition the technology to the fleet and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aircraft and industrial or recreational machinery could benefit from increased bearing life and reliability.

REFERENCES:
1. SAE AS81819 (R) Bearings, Plain, Self-Aligning, Self-Lubricating, High Speed Oscillation -65 to 160 deg.F General Specification for) C (03/2008) http://www.sae.org

2. SAE AS81820 (R)
Bearing, Plain, Self-Aligning, Self-Lubricating, Lined Bore, Low Speed, Wide, Chamfered Race, -65 to +325 °F) C (03/2008) http://www.sae.org

3. MIL-HDBK-1599A Department of Defense Handbook, Bearings, Control system Components, And Associated Hardware Used In The Design and Construction of Aerospace Mechanical Systems and Subsystems (03/1997) http://www.everyspec.com/MIL-HDBK/MIL-HDBK+(1500+-+1799)/MIL_HDBK_1599A_1831/

KEYWORDS: plain bearing, self lubricating bearing liner system, contamination resistance, low friction, maintenance

N131-017 TITLE: Polarization insensitive diffraction grating for Navy tactical airborne high energy lasers (HEL) applications

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PMA-265

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and fabricate a polarization insensitive diffraction grating for High Energy (HEL) Laser Weapon systems on tactical air platforms.

DESCRIPTION: Recent developments in subsystem performance have made realistic the potential for the incorporation of high energy lasers (HEL) on tactical aircraft. High power fiber lasers have shown the potential for achieving 1 kW or more per fiber. By combining multiple fiber lasers via spectral beam combination (SBC) it is possible to achieve power levels suitable for the demonstration of a Laser Weapon System (LWS). In SBC, each individual fiber laser operates at a different wavelength and when the output of each individual fiber is incident on a diffractive element at the appropriate angle, all of the outputs can be spatially coaligned and directed at the target by the beam director system. The volume and weight restrictions of air platforms as well as performance requirements have placed serious constraints on the overall system. Improvements in system efficiency lead to reduced requirements for prime power and thermal management and therefore an overall reduction in weight and volume. A key component for achieving SBC is the diffractive grating. The SBC grating determines the combining efficiency of the system and must be able to withstand the full output of all of the individual fiber lasers. The focus of this topic is for a high power SBC grating that can address the requirements of multiple platform-based high energy laser systems, such as the F/A-18 and MH-60S.

These requirements include:
• High power handling capability: The grating should withstand a minimum of 20 kW/cm2 (goal of > 30 kW/cm2).
• High efficiency: The grating should have a minimum diffraction efficiency of 98% near the grating Littrow angle over a 40 nm bandwidth near 1.06 ?m (goal of > 99% efficiency) independent of polarization.
• Polarization insensitivity: The high efficiency should be maintained regardless of the polarization state of the input laser beams.
• Absorption: The diffractive grating should have an absorption less than 1 percent (goal < 0.1%).
• Clear aperture: The diffractive grating should have uniform performance (ie, meets minimum requirements above) with a usable area in excess of 79 cm.

Innovative ways to improve the performance of diffractive gratings for SBC are sought. Although specifically targeted for implementation in future high energy laser systems for tactical air platforms, the same technology would undoubtedly provide benefits to ground and sea based high energy lasers as well. The target of this program will be to demonstrate a polarization insensitive, highly efficient grating with high power handling capability. Operation in a military environment will be essential for future applications; therefore the grating must be robust to the shock, vibration, and temperature environments of a deployed device. Finally, the resultant diffractive element must be designed in a way as to be consistent with current state-of-the-art high volume manufacturing practices in the industry. The goal for the end of the program would be to achieve a per unit cost of less than $30,000.

PHASE I: Develop a conceptual design for a polarization insensitive, high efficiency diffraction grating that meets Navy requirements. Include methodology and prototype performance that will demonstrate the proposed concept at the performance above.

PHASE II: Develop detailed designs for the Phase I diffraction grating and fabricate a limited number of gratings suitable for proof of concept testing. Conduct preliminary testing in a laboratory and in Government-sponsored facilities, including appropriate environmental considerations and report the results of this preliminary testing to the Government. Provide sample(s) to the Navy for evaluation.

PHASE III: Scale up for mass production of the grating. This grating, upon meeting Navy requirements, will be transitioned into various laser weapon programs on multiple air platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial use is in for lasers systems that operate in a rugged environment where efficiency is critical to system weight and volume requirements.

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1. Thomas H. Loftus, et al.(2007). 522 W average power, spectrally beam-combined fiber laser with near-diffraction-limited beam quality. Optics Letters 32, 349-51

2. S. J. Augst, et al. (2003). Wavelength beam combining of ytterbium fiber lasers. Optics Letters 28, 331-4

KEYWORDS: Precision Optical Systems; Diffraction gratings; High Energy Laser Systems; Spectral Beam Combination (SBC)

N131-018 TITLE: Decoupled Rendering Channels to Reduce Logistical Support Spares Requirements of Large Scale Training Centers.

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMA-205

OBJECTIVE: Demonstrate on a suite of flight simulators how to innovatively decouple image rendering channels from individual trainers, and instead provide imagery to multiple trainers simultaneously via a centralized pool of logistical support/spares resources, over a local fiber optic video distributed network.

DESCRIPTION: Currently, the hours of availability provided by each stand-alone simulator are constrained by each trainer’s dedicated image generation (IG) hardware functionality and the currency of the images on that hardware. Moreover licensing and maintenance of today's image generators is fragmented, duplicative, and costly.

In order to better keep pace with continually updated and increasingly detailed imagery being made available, research is needed to determine how image generation architecture could be improved. Experts predict that large scale training centers may be not viable in the long term without this type of innovation, due to the complexity and detail available for rendering. Just as image generation architecture has moved from dedicated purpose computing into PCs, it is inevitable that the next step would be into distributed fiber optic video distributed network, thus providing better logistical/maintenance support and sparing for large scale simulation (e.g., see reference for the new P-8A aircraft) training centers, and commercial training facilities that provide multiple flight simulators at one location.

The resulting centralized Image Generation (IG) should improve availability, reduce costs, and make possible uninterrupted training to occur - while conducting simultaneous imagery updates.

PHASE I: Design and prove the feasibility of a systems architecture for a suite of flight simulation devices that could centralize imagery generation. Address production cost issues, licensing issues, and design risks. Where possible, identify and mitigate risks anticipated to arise during Phase II. Demonstrate conceptual design and project feasibility of the new system configuration.

PHASE II: Develop the technical solution as a prototype. Demonstrate and validate the device effectiveness in a training system.

PHASE III: Integrate the solution into training simulator programs. Transition the proposed solution.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Expanding the success of the new centralized imagery production architecture simulator systems configuration to other military, foreign military, and the commercial simulation industry.

REFERENCES:

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3. Centre for the Protection of National Infrastructure (2010). Information Security Briefing 01/2010: Cloud Computing, http://www.cpni.gov.uk/Docs/cloud-computing-briefing.pdf

4. STRATEGIC PLAN FOR THE NEXT GENERATION OF TRAINING FOR THE DEPARTMENT OF DEFENSE, September 23, 2010 Office of the Under Secretary of Defense (Personnel & Readiness) Readiness and Training Policy and Programs.

5. P-8A Training Simulators Make their Debut, (2012). NAVAIR News. http://www.navair.navy.mil/index.cfm?fuseaction=home.NavairNewsStory&id=4898

KEYWORDS: Decoupled Rendering; training; system architecture; image generation; Simulation, Logistical support/Spares

N131-019 TITLE: Non-Mechanically Moving Solar Directing System for Photovoltaic Modules

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: NAVFAC Directed Energy Program

OBJECTIVE: The objective is to develop a cost effective device that can track the sun and direct solar irradiance onto a photovoltaic panel without the use of mechanically moving parts.

DESCRIPTION: Naval Facilities Engineering Command (NAVFAC) works to meet renewable energy goals by implementing cost effective systems. Photovoltaic (PV) systems that utilize solar tracking can significantly increase energy production, but the operation and maintenance requirements and associated costs make the technology unattractive for Navy-owned PV systems.

New approaches, such as the ARPA-E funded project on “Optofluidic Solar Concentrators,” show that it is theoretically possible to direct sunlight using non-mechanically moving parts. Successful development of this type of technology and others like it will allow for the Navy to continue to implement higher performing PV systems with a minimal increase in operations and maintenance cost compared to that of fixed-tilt PV systems.

Proposed technical approaches should consider, but not be limited to, the following areas of concern:
1) Additional weight
2) Heat gain/impact of the light directing material and PV module
3) Material life matching that of PV modules
4) Tracking capability and technical approach
5) Transmissivity changes due to sun angle
6) Performance reduction due to the inability to use diffused solar irradiance
7) Impact to effectiveness due to environmental soiling

PHASE I: Determine the feasibility of developing a non-mechanically moving solar directing system how it can be incorporated into existing PV technology/manufacturing processes. Evaluate attributes of the system, including solar tracking capability, product/material longevity and effectiveness over time, using detailed models or small subscale components. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Fabricate and test a working prototype on a PV module/cell based on the Phase I study. Address issues and provide guidance relating to cost effective manufacturability for future commercialization of the technology.

PHASE III: Fabricate one or more functional PV panels (i.e., a panel with multiple PV cells and an inverter) based on cost effective manufacturing guidance. Suggest specific detailed design changes to make production models more reliable and cost competitive with the manufacturing of conventional PV panels.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Solar PV panels are commercially available, but adoption of solar tracking PV systems have been limited to utility scale projects. More effective, fixed solar PV systems can increase the return on investment of a PV system, such as for rooftop PV, and can benefit both the private industry and DoD installations if the technology can be demonstrated to work and the manufacturing costs can be made comparable to that of conventional PV panels.

REFERENCES:
1. http://arpa-e.energy.gov/ProgramsProjects/OtherProjects/RenewablePower/OptofluidicSolarConcentrators.aspx

KEYWORDS: solar; photovoltaic; PV; tracking; renewable; energy

N131-020 TITLE: High Energy and Power Density Electrical Energy Storage Device

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Electronics

ACQUISITION PROGRAM: NAVFAC Directed Energy Program

OBJECTIVE: The objective is to develop an energy storage device that has both high energy and power density. The device would be robust with a wide temperature range, long life, and exhibits minimal degradation under numerous recharge cycles. Energy storage per kW-h would have to be cost competitive with existing battery technology to be viable for infrastructure applications.

DESCRIPTION: Naval Facilities Engineering Command (NAVFAC) has a need for a robust electrical energy storage device. Traditionally chemical batteries have been the primary technology for powering portable devices, remote asset monitoring, electric vehicles, and small to large scale utility back up power supplies. Battery technology is limited by the need for an electrochemical reaction which is not completely reversible and is temperature dependent. Infrastructure applications have unique requirements different than consumer electronics which batteries are better suited for. These requirements include operation in harsh temperature ranges, and difficult to access locals that demand maintenance free, long life operation. Current Ultracapacitor technology offers all these advantages but have energy densities that are only 10-20% that of traditional batteries.

Commercially available Ultracapacitors or Supercapacitors employs an EDLC (Electrochemical Dual Layer Capacitor) architecture that maximizes the surface area and minimizes charge separation distances to achieve high capacitance. Maximum energy is a function of dielectric volume, permittivity, and dielectric strength per distance.

EDLC thus only maximizes the (A/d) geometric term, while the electrolytes used have low relative permittivity e, and break down voltages Vb. A materials solution is sought that would complement existing EDLC structures with significantly higher e and/or Vb, i.e. by using newer electrolyte solutions or coating the carbon powders, nanofibers, or aerogels with a high dielectric coating. Alternatively solid state ceramic dielectric materials could be used to maximize permittivity and break down voltages, though with a lower geometric factor.

Recent fabrication technologies for multilayer ceramic capacitors (MLC's) have improved significantly, permitting both lower cost and higher quality devices with low defects. These MLC use high dielectric ceramics that theoretically are capable of very high breakdown voltages, but voids and other defects have limited the electrical break down. Submicron thick film and size powders with glass encapsulation have been shown to provide significantly higher break down voltages because of less voids and defects. It has been suggested that these materials can have Vb of 8MV/cm, which could translate to energy densities of greater than 500 W-h/L.

Advanced Ultracapacitor concepts are sought that would maximize both geometric and materials parameters to provide energy densities greater than current Li-ion batteries, have low maintenance, and long operational life spans of 10 years with greater than 100,000 recharge cycles. Materials selection and manufacturing processing should be compatible with cost restrictions, such that the final product should be price competitive with Li-ion storage, and practical for large scale infrastructure applications. Proposals should offer a conceptual architecture and provide a quick calculation of energy density to estimate feasibility of obtaining the objective energy density.

PHASE I: Develop the process and fabricate a small laboratory device for testing. Measure capacitance and material properties of the device to extrapolate expected energy density. Laboratory device should meet the following targets:
- Energy storage density of 200 Wh/L
- Power density of 5000 W/L
- 25,000 full charge/discharge cycles while maintaining 80% of initial performance
- operational at temperatures from -32F to 150F

PHASE II: Build and demonstrate a device capable of 1kW-h of energy storage. Measure device performance metrics i.e., recharge cycles, temperature range, current leakage, etc. Provide cost breakdown of device and path to a cost objective of under $500/kW-h.

PHASE III: Build a 5kW prototype that can be integrated into a modular system with capacity up to 500kW-h of energy storage. Target application will be in a micro-grid for power backup and power stabilization. Evaluate unit for reliability, operating thresholds, and integration issues.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial power utilities, telecom UPS, and electric vehicles are potential applications with similar energy capacity requirements. Smaller portable electronics, remote wireless devices, and portable lighting would also benefit from the quick charge, and robust operating life of these energy storage devices.

REFERENCES:
1. Ezzat G. Bakhoum, "New Mega-Farad Ultracapacitors", IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 56, no. 1, p.14, 2009.

2. Gordon R. Love, "Energy Storage in Ceramic Dielectrics", Journal of the American Ceramic Society Volume 73, Issue 2, p.323-328, February 1990

3. I. Burn and D. M. Smyth, "Energy storage in ceramic dielectrics", Journal of Materials Science, Volume 7, Number 3, p. 339-343, 1972.

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5. US Patents #6078494, #7729811

KEYWORDS: Supercapacitor, ferroelectric, Ultracapacitor, EDLC, dielectrics, pseudocapacitor

N131-021 TITLE: <u>Underwater Directional Bore Tracker</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IV

OBJECTIVE: The objective is to develop a simple Horizontal Directional Drilling (HDD) tracking tool that works underwater in the near-shore and surf zone. Accurate tracking is critical to make sure the drill is guided to the proper exit point and the utility survives for its planned service life as well as being environmentally benign.

DESCRIPTION: Naval Facilities Engineering Command (NAVFAC) uses HDD for cables and utilities to cross under the aggressive and hazardous zone at the sea-shore interface. Horizontal Directional Drilling has become common practice for routing utilities and communications cables under waterways and under the sea-shore interface. HDD minimizes environmental impacts and eliminates the risk of abrasion and damage from heavy wave forces or damage from anchors and dredging.

The ability to track and guide the HDD drill head is important for environmental and survivability concerns. Accurate tracking is critical to make sure the drill is guided to the proper exit point and the utility survives for its planned service life. In addition, accurate tracking minimizes the environmental risk of an excessive release of drilling mud into the ocean. A robust low-frequency hand-held diver-operated tracking system is needed that works underwater with small HDD systems used by the Navy.

The technology to guide and track an HDD drill string is well developed for terrestrial applications. The most accurate HDD tracking systems incorporate a wire-line system using DC magnetic field and a sensor grid placed on the surface. This type of system can be costly and requires specialized training to operate. Placement and survival of a grid system is difficult or impossible in the surf zone. In addition, wire-line tracking systems do not work for smaller HDD systems used by the Navy. Another commercial technology used for tracking is a walkover system, which does not use a wire-line, but relies on a battery operated transmitter placed in the drill head. However, walkover systems operate at frequencies that are range limited and can be disrupted by conductive media. Commercial walkover systems do not work underwater.

PHASE I: Develop a concept and fabricate a small laboratory device for testing. The sensing detector would be a battery-operated hand-held unit that works underwater when operated by a diver. The transmitter would also be battery-operated and placed inside the drill head, and would transmit low-frequency AC “tones” less than 100 Hz. The system should be capable of measuring signal strength and direction at ranges of 50’ to 100’ through the earth and water. The detection device must accurately detect the transmitter unit with an accuracy of +/-5% of slant range. This innovative system must be impervious to adjacent conductive media, such as other pipelines and cables. Multiple frequencies and selectable frequency options shall be considered. Remote frequency control of the transmitter shall be considered as a feature. Research shall include analysis of optimal frequency or combination of frequencies for underwater tracking.

PHASE II: Build and demonstrate the Phase I detection and transmission system and test it in a near relevant environment. The prototype should be modified based upon testing and altered prior to field testing.

PHASE III: Build and validate a system that can be fielded and operated as intended.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial electric and gas utilities, telecommunications, seawater intake, oil and gas pipeline.

REFERENCES:
1. Directionally Drilled Bores For Remote Cable Landings, Sinclair, Nate et al, NAVFAC Engineering Service Center, 1 Sept 2003.

2. Horizontal Directional Drilling (HDD) Systems for Pilot Bore Drilling in Mixed Soil Conditions and Rock, Gerald A. Strangl, http://www.ospmag.com/files/pdf/HDDSystemsforMixedConditions-111508.pdf

KEYWORDS: Horizontal Drilling; cable shore landing; cable tracking

N131-022 TITLE: Craft Hull Impact and Abrasion Resistance

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 325G, Small Boast and Craft Program Office

OBJECTIVE: Development of an innovative material solution and applicable manufacturing techniques to provide improved protection for aluminum and composite USN small craft hulls against excessive abrasion and impact damage.

DESCRIPTION: Naval expeditionary patrol, interdiction, and assault craft experience hull impacts and abrasion in the performance of common operational tactics and procedures. The hulls (Ref 1) are subjected to abrasion due to beaching and grounding, and suffer impact damage to various areas above and below the waterline during launch, recovery, interceptions of rouge craft, landings at un-improved sites and marine structures as well as from un-intentional contact with objects at or below the water's surface. The current abrasion or impact resistance solution for aluminum hulls is the application of add-on rubberized rub-rail materials, the use of a hull collar or the inclusion of a sacrificial aluminum doubler-plate on the bow keel. Rub-rail and collar materials require mechanical fasteners and hull penetrations and can enable corrosion at points of contact with the aluminum hull, often failing at the point of mechanical attachment and requiring maintenance of the surfaces to which they mate. The aluminum doubler-plates installed on in-service craft wear through requiring repair or replacement which is costly and requires the use of specialized personnel. Additionally, fabrication and welding are difficult and time consuming due to the complex shape and awkward position of the plate on the hull. Repair of the bow plate alone costs approximately $10K and requires 10 or more days out of service, not including the transportation time to a depot level maintenance facility and any work delays. During these types of repairs, the craft is not available as a mission ready asset. Similar costs and times to repair are estimated for other areas of the hull where harmful impacts occur and a repair is required. Composite boats have similar life cycle challenges. Two methods are currently employed to provide protection to the composite bow keel, a laminate in place or an add-on solution. Craft have been delivered with added protection laminated into the original mold and have also been modified with a shop built, laminated cut-water part attached with adhesive and a vacuum bag to clamp the part in place (Ref 2). As with the doubler-plate on aluminum craft, this solution experiences similar performance challenges in expeditionary environments. These highly integrated types of solutions are costly and labor intensive to install and both the 'in place' and 'add on' options pose challenges to in-place repair. For both aluminum and composite hulls, the currently used commercially available solutions are considered the "state of the art". Future technology solutions in areas such as, but not limited to, polymer science, nano-structure materials, bonding materials science, etc. could be viable; however, performance and suitability for use in the strenuous operating environment discussed in this topic vice recreational boating applications have not been demonstrated nor proven.

This topic seeks to develop innovative material solutions and applicable manufacturing techniques that can be implemented to provide improved hull-form abrasion and impact resistance for a seven year craft service life with only minor field-repairs, such as filling of gouges or smoothing of roughened surfaces. Concepts proposed should not alter or propose alternate standard base hull materials nor require installation via mechanical fasteners or through-hull penetration. Concepts must be able to conform to various hull shapes and surfaces (bow keel/fenders, transom corners, keel guards, strakes) and should not serve as a catalyst for corrosion. Concepts should be easily repairable (not requiring specialized skills such as metallurgical welding, specialized composite materials mixing, etc), easily replaceable if damaged beyond repair and should be implementable with minimal manpower, simple tools and little to no training. Proposed material solutions and repair methodologies must not degrade craft performance due to excessive weight or flow resistance. Proposed concepts must also demonstrate more durable protection and higher strength than 5086-H116 aluminum, or the Navy composite solutions. Proposed concepts will be compared and evaluated for suitability using ASTM International abrasion and bond-strength tests, Det Norske Veritas (DNV) drop impact test (Ref 3), as well as any other relevant industry test proposed by the candidate to measure impact or abrasion that would aid in the identification of a superior material solution (Ref 4). Achieving this topic's goals would directly increase mission readiness by: shortening down-time due to repair or replacement; increase mission capability in that the hull will be able to endure the regular beaching and impacts; reduce life cycle costs by providing a more durable and cost effective solution that can be easily repaired and replaced if necessary without the assistance of depot maintenance facilities and specialized skill-sets.

PHASE I: The company will develop an innovative material concept and any applicable manufacturing techniques that improve protection for aluminum and composite expeditionary and combatant craft hulls against excessive abrasion and loss of hull material. The company will demonstrate the feasibility of the concepts in meeting the Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones while addressing technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype of a bow keel and shell plate region to represent key impact zones for evaluation in a laboratory environment, as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for effective hull-abrasion resistance performance. Concept performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles and field repairs. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a cost benefit analysis as well as a Phase III development plan to transition the technology to Navy use.

PHASE III: Working with government and industry, the company will build full-scale add-on prototypes for protection of the bow keel, the upper hull shear and bow, and transom platforms or side shell corner protection and install the parts onboard a selected combatant craft. The company will conduct extended onboard operational testing to validate, certify, and qualify for Navy use. The small business will pursue global commercial markets in applying the new technology to commercial craft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The developed technology will have direct applicability to over twenty boat builders who serve the U.S. military and commercial markets, as well as the international small boat commercial industry.

REFERENCES:
1. Military Craft and Boats, http://www.globalsecurity.org/military/systems/ship/boats.htm

2. Brian Hayman, Andreas Echtermeyer, Dag McGeorge “Use of Fibre Composites in Naval Ships”, Det Norske Veritas AS, Hovik, Norway, 2001.
http://research.dnv.com/euclid_rtp3.21/PW_Tools/PWE/Input/WARSHIP_2001_Hayman.pdf

3. Det Norske Veritas, Standard for Certification No.2.9 Type Approval Programme No.1-501.15, October 2009.
https://exchange.dnv.com/Publishing/TAP/TAP415.pdf

4. ASTM Standard G190 - 06, “Standard Guide for Developing and Selecting Wear Tests” ASTM International, West Conshohocken, PA, DOI: 10.1520/G0190-06, http://www.astm.org/Standards/G190.htm

KEYWORDS: hull impact; abrasion resistance; beaching plate; expeditionary craft; combatant craft; small boats

N131-023 TITLE: Heaters for Electron Guns

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop alternative manufacturing processes design and/or materials to improve the heater system in dispenser type cathodes.

DESCRIPTION: Currently the Navy is using Rhenium-Tungsten heater wire used in existing vacuum tube technologies (Refs. 1, 2, 3, 4, 5) for its electron guns. Domestic manufacturing sources for this type of heater wire are decreasing causing a continual increase in the costs to both government and industry to manufacture and purchase the wire. Various factors combine to create the diminishing manufacturing base. The need for the wire is a low volume requirement; the current manufacturing processes are labor intensive; and the materials to manufacture the wire are in foreign countries. The Navy has researched current materials and there are no materials on the market that would meet the current desired replacement. This situation results in a two-fold need. One is to develop new low cost materials for the heater wire. The other is to develop the manufacturing and producibility processes for the newly developed materials.

The Navy needs a new design technology that facilitates establishment of additional domestic providers of the heater wire. The new technology may be an innovative manufacturing process, new materials that replace the current Rhenium-Tungsten heater wire, or a combination of both. This technology will replace the current 0.015-0.029 inch diameter Rhenium-Tungsten wire. The new technology must lower the costs and meet the current requirements of the heater system wire including electrical and mechanical performance and reliability, thus addressing system availability. The Navy anticipates the desired technology will replace the wire used in the electron gun heater wire assemblies in magnetrons, klystrons, and Traveling Wave Tubes (TWTs).

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for an improved electron gun heater system that meet the requirements described above. The contractor will demonstrate the feasibility of their technology to meet the Navy need and show their concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material component testing and analytical modeling or a combination of these. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the contractor will develop a process/capability prototype for evaluation. The evaluation will determine the capability of the prototype to meet the Navy performance goals defined in the Phase II development plan and the Navy application requirements for microwave tubes such as magnetrons, klystrons, and TWTs with the electron gun heater technology. The performance will be demonstrated through material processing, prototype evaluation and modeling, or analytical methods for all application performance parameters. Evaluation results will be used to modify the prototype design and manufacturing processes to meet Navy requirements for an operational electron gun heater. The contractor will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: If Phase II is successful, the contractor will be expected to support the Navy in transitioning the technology into manufacturing for Navy use. The contractor will be responsible for prototype design changes based on results of operationally relevant environment testing. The contractor will support the Navy for test and validation to certify and qualify the manufacturing and heater systems for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Microwave tubes with dispenser cathodes are utilized in many military systems and commercial or government systems. This topic addresses manufacturing capabilities and material to support many microwave tubes such as magnetrons, klystrons, and TWTs used in Navy and commercial applications. Rhenium-Tungsten wire is currently used for heating elements in high temperature furnaces, thermocouples, and in electronics. The new capabilities and materials would have commercial applications.

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2. Lough, Walt. “DLA Strategic Materials information Briefing”, 30 June, 2011, http://www.dtic.mil/ndia/2011DLA/ThursdayDLAStrategicMaterials.pdf >

3. “Reestablishing Strategic and Critical Material Security in the Department of Defense”, 11 May 2011, http://e2s2.ndia.org/schedule/Documents/Abstracts/12432.pdf

4. China Tungsten Industry report 2010-2011, http://www.researchandmarkets.com/reports/1653772/china_tungsten_industry_report_2010_2011

5. “Reconfiguration of the National Defense Stockpile” – Report to Congress April 2009, https://www.dnsc.dla.mil/pdf/NDSReconfigurationReporttoCongress.pdf

KEYWORDS: Rhenium-Tungsten; Klystron; heater wire; Magnetrons; Traveling Wave Tubes (TWT); Cathode Tubes

N131-024 TITLE: Three Dimensional Ship Modeling for Submarine Combat Systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS 5.0, Anti-Submarine Warfare Command and Control Systems

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop a ‘two dimensional digital image to three dimensional model’ conversion tool of ship digital images that enhance submarine combat system applications.

DESCRIPTION: Three dimension (3D) ship models are used to support mensuration, classification, and identification tasks in a submarine combat system. 3D computer aided design (CAD) models are not widely available for most classes of ships. They must be manually developed using a variety of photographs and information from ship references such as “Jane’s Fighting Ships.” Development of 3D models requires significant non recurring engineering costs upwards of $5K per model and requires skilled engineers. With several thousand classes of ships in existence today and new classes of ships being developed every year, non-recurring engineering costs are high. The capability to generate a 3D model in minutes will result in significant cost savings. Often submarines encounter vessels for which they have no 3D model. The capability to quickly build a 3D model from existing two dimension (2D) digital images in the submarine’s combat system is needed.

Software is commercially available today for building 3D models from photographs. This software is based on the science of digital photogrammetry (Ref. 1, 2). This software can be broken into two categories: semi-automatic and manual methods. The semi-automatic methods do not generally work on typical 2D images of ships. These methods require near perfect digital images taken in good uniform illumination with significant overlap between images. This is usually not the case for a compilation of images taken by submarines. The manual methods require painstaking matching of points between images. These methods are much too time-consuming and complex for a typical submarine combat system operator. A method is sought that works with minimal operator intervention (Ref. 3).

Model-based automated classification software uses 3D models to match images of vessels to their corresponding models. Without a 3D model for a target, the target will be mis-classified or designated as an unknown target. The capability for semi-automatically generating 3D models from 2D digital images should eventually result in a much larger model set, which will result in improved submarine combat system operator effectiveness. The Navy seeks a semi-automated method for generation of 3D models from 2D digital images requiring minimal operator intervention or editing using photogrammetric techniques. This method should use sets of images taken from a variety of ranges, cameras, sea states, weather conditions, and illumination conditions. Sophisticated image processing techniques should be used to segment vessels from land, clouds, waves, and other objects in the background. This method should be able to utilize known range information on the ship from other ownship sensors and be able to input data from known ship references, such as “Jane’s Fighting Ships”.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for a 3D model generation algorithm that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing the algorithm on compilations of ship photographs for several ships. Specific theory/algorithms should be identified to address all steps in the 3D model generation process. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype 3D model generation algorithm that operates in real time on a variety of stand-alone hardware with minimal latency and operator intervention, ready for a land-based evaluation. System performance will be demonstrated through evaluation of the algorithm using a variety of sets of photographs of several classes of ships from submarine periscope data sets. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will integrate the 3D model generation algorithm into a submarine combat system to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: As already discussed there is a market for this type of technology. Software developed under this program should be applicable with some modification to many other commercial and military applications including the modeling of aircraft, automobiles, buildings, and private vessels.

REFERENCES:
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2. Pollefeys, Marc and Van Gool, Luc. "From Images to 3D Models." Communications of the ACM, Vol. 45, Issue 7, July 2002, pp. 50-55.

3. Franken, et al. “Minimizing user intervention in registering 2D images to 3D models.” Visual Computing, Vol. 21, 2005, pp. 619-628.

KEYWORDS: Photogrammetry; 3D models; digital image; submarine; image processing; building 3D models; two dimensional to three dimensional

N131-025 TITLE: Real-Time External Sensor Probe that is Deployed from an Underwater Vehicle

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS397; Ohio Replacement Program ACAT I

OBJECTIVE: Develop an expendable, reliable, low cost autonomous sensor probe which can be deployed from a submarine that is capable of providing real-time measurements of conductivity, temperature, and depth back to the submarine in real-time.

DESCRIPTION: Accurate conductivity, temperature, and pressure information in a water column is critical to a submarine's communication, sensing, and maneuvering capabilities. This information needs to be accurate and rapidly acquired for depth transitions as well as defining submerged operating envelopes. A real-time sensor system will greatly improve a submarine's communication, sensing, and maneuvering capabilities especially in regions with large variations in environmental conditions, usually the result of considerable ice melt, evaporation or large temperature gradients.

The current probes used onboard Navy submarines to obtain conductivity, temperature, and depth (CTD) information are very limited and costly. These probes do not provide information in real-time (the probes have to travel to the surface before data transmission), experience high failure rates, and cannot be autonomously launched. Although developments have been made in packaging and connectivity of sensor probes (such as the research in references 1, 2, and 3), much of the current technology is still expensive or impractical to deploy from submarines.

The Navy desires an innovative solution for an expendable, reliable, low cost autonomous sensor probe that can be deployable from a submarine and capable of providing real-time measurements of conductivity, temperature, and depth data back to the submarine in real-time. Such capabilities do not currently exist or are too costly for acquisition. Novel approaches to the design and implementation of a low-cost expendable CTD sensor which will transmit data during both the ascent and descent of the probe are sought. Proposed designs should be able to meet the following goals: failure rate less than 10%; provide autonomous deployment, measurement resolution greater than or equal to 10 ft during ascent and 5 ft during descent, and digital output for interfacing with platform from which it was deployed. Furthermore, the system should have the ability to allow deployment platform to maneuver while device is profiling, operate at an ascent and descent rate greater than or equal to 10 ft/s and have a reduced production costs.

PHASE I: The company will develop concepts for a real-time sensor probe that can be deployed from the OHIO Replacement Submarine Class or any back-fit of the OHIO Class that meets the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The sensor probe must be able to integrate with Commercial-Off-The-Shelf conductivity, temperature, and depth (CTD) sensors. All concepts will be evaluated on how well they address the probe goals and how they will demonstrate feasibility through a business case analysis that must be submitted with any and all concept ideas. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Real-Time Sensor Probe. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Real-Time Sensor Probe which is deployable from the hull of a submarine for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use on OHIO Replacement and existing platforms such as SSBN, SEAWOLF, LOS ANGELES, and VIRGINIA class submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial application and dual use should be described in sufficient detail so that a person unfamiliar with the topic can appreciate applications other than the military. Some specificity of the application and examples will help those unfamiliar with the topic to appreciate potential commercial use. This technology can be applied to commercial sectors such as drilling operations and explorations.

REFERENCES:
1. Bishop, C. M. “Sensor Dynamics of Autonomous Underwater Gliders,” Master Thesis, Memorial University of Newfoundland, May 2008.

2. Forrest, A.L. et al. “Investigation of under-ice thermal structure: small AUV deployment in Pavilion Lake, BC, Canada.,” Oceans 2007. UBC, Vancouver.

3. Laval, Bernard, John S. Bird, Peter D. Helland. "An Autonomous Underwater Vehicle for the Study of Small Lakes." Journal of Atmospheric and Oceanic Technology. 2000, 17, 69–76.

KEYWORDS: Submersible sensor, Real-time connectivity, Environmental Monitoring, Conductivity of sensor probes, Ocean Temperature variations, Real time ocean density measurements, Conductivity Temperature Depth sensor probe

N131-026 TITLE: <u>Life of Ship Flexhose</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Advanced Submarine Systems Development (SEA073R)

OBJECTIVE: The objective is to develop an affordable flexible hose that last the average life of a ship.

DESCRIPTION: Flexible hoses (Flexhoses) are versatile hoses used aboard US Navy ships for many applications. Flexhoses are primarily used for resilient mounted equipment to mitigate shock and sound attenuations. Flexhoses are currently used as piping for various fluids, such as freshwater, seawater, and lubrication oil, and in several different types of equipments, see reference.

However, there are several limitations to the flexhoses currently available. Flexhose failures are difficult to predict and assess. Some common causes of flexhose failures include UV, sunlight exposure, high temperature fluids, and pedestrian traffic. Furthermore, flexhoses often fail from the inside. Little, if any, indication is provided on the outside that the internal hose wall might be wearing away. This is a big problem, especially since the internal hose material that erodes away can damage equipment downstream. As a result, flexhoses are currently replaced approximately every six years as preventative measures. This requires a significant amount of time and money. The current industry options for flexhoses that best meet Navy requirements are made by synthetic rubber. Although synthetic rubber hoses are typically cheaper than other hose options (synthetic rubber flexhoses can sometimes range between $5-$45), they are often soft and susceptible to internal wear and tear. The more durable hose options, for example thermal plastic, Teflon, silicon, corrugated metal options, are too costly. For example, Teflon hoses can within stand high temperatures but is too brittle and is too easily damaged.

The purpose of this SBIR is to develop concepts for a flexhose that is flexible, durable, affordable, and can last the average life of a ship (approximately 40 years) without being replaced. The hose must be comparable or better in affordability as the current synthetic rubber hoses used and meet the current MIL requirements for hose and fittings, see references below. The flexhose concepts must also be durable; able to withstand fluid temperatures in excess of

200 degrees Fahrenheit without degradation and UV and sunlight exposure. Furthermore, the flexhose concepts must be adaptable for nominal hose sizes and be able to use reusable fittings.

PHASE I: The company will develop concepts for flexhoses that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and/or analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy needs for flexhoses. Evaluation results will be used to refine the prototype into an initial design that will meet Navy needs. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop flexhoses for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Flexhoses are currently used in many industry applications, from automobiles to airplanes. A successful SBIR project has many commercial and private applications and can easily be commercialized.

REFERENCES:
1. Banks, Carl “Navy Flexible Hose Assemblies,” SAE Technical Paper 871384, 1987, DOI: 10.4271/871384.

2. MIL-H-24135B Specifications for hose, synthetic rubber, wire reinforced for flexible hose assemblies.

3. MIL-F-24787 Specifications for fittings for flexible hose assemblies.

KEYWORDS: Life of ship flexible hoses; durable; affordable; flexhose

N131-027 TITLE: Ocean Sensor Interface Simulation for Integration Testing

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PEOIWS 5.0 Undersea Systems Program Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop methods to simulate the complex ocean data produced by new sensors as they will be seen by physical interfaces to combat and acoustic systems in support of developmental integration efforts.

DESCRIPTION: In order to introduce new sensor technology into combat systems, it is necessary to model traffic coming across the interface between the combat system and the new sensor. Current practice uses simple simulations during development which mainly simulates the known physical properties of the interface. It is currently beyond the state of the art to model how an actual ocean sensor array will impact the physical interface. This lack of ability to model details of the physical sensor interface including interface to an acoustic array in the development of Naval weapon systems inhibits the Navy's ability to ensure tactical capabilities of the systems are fault tolerant when they reach deployment (Ref. 1).

Technology that could enable Navy to stimulate the information passed by the new sensor arrays across the physical interfaces would permit system testers to mimic the actual tactical use of the system. This would expose latent design defects early in the development cycle, allowing testers to employ stress and casualty mode scenarios in their test plans. Defects indentified within these test scenarios could be addressed by a tester in a controlled environment suitable for defect resolution, instead of in the field by a war fighter attempting to complete a mission. Mission capability will be improved by the deployment of a more mature and robust system and reduce system development costs.

Initial target for this technology would be information systems for the Maritime Surveillance Systems Integrated Common Processor (MSSICP) program and the AN/SQQ-89 Undersea Warfare (USW) Anti-submarine Warfare (ASW) System program. The MSSICP assists operators in localizing and tracking possible surface and subsurface threats. The AN/SQQ-89(V) is comprised of subsystems, each of which supports the overall system mission by providing different capabilities supporting USW Search, Detection, Classification, and Localization, and Fire Control and Torpedo Alert and Engagement Current practice in these programs is to wait until installation at the site of the sensor to conduct regression testing. This practice introduces unnecessary risk and cost because it is the first time the processing system is tested with the refreshed sensor interface. Any issues that arise at this point are costly because the system has progressed through the development stage. The new technology will identify and address problems early in the development cycle where the resolution costs are lower (Ref. 2, 3).

Innovative concepts, products, methods, or techniques are needed to develop a simulation with sufficient sensor interface fidelity to remove or reduce the previously cited costs and risks. The developed simulation method should use actual array specifications augmented with other features to ensure comprehensive test coverage. The simulation will exercise standard interface protocols such as up-link, down-link, and health status. They will also include all current acoustic and non-acoustic sensors and associated sonar telemetry pertinent to the Maritime Surveillance Systems ICP and the AN/SQQ-89 Undersea Warfare Anti-Submarine Warfare System programs. Basic target capabilities, including calibrated noise, are desired in the developed simulation. Electrical load simulation will also be included to verify power supply capacity and fidelity. Augmenting the simulation of acoustic and non-acoustic sensors used for Anti-Submarine Warfare with common acoustic and non-acoustic failure modes will allow the response of the downstream processing components to be stress tested much earlier in the system life cycle.

The Phase I effort does not require access to classified information. Unclassified complex level data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certifications for handling classified data.

PHASE I: The Company will develop concepts for a Physical ASW Sensor Interface Simulation that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by concept testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype simulation of a towed array and acoustic source for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals identified in the Phase II development plan. System performance will be demonstrated through prototype evaluation, modeling, or analysis over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Physical Sensor Interface Simulation for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The oil and natural gas exploration industries have environments that are difficult to access and gather data in. The ability to test processing systems with robust simulations of the interfaces and physical data messages passed by sensors would reduce risk and cost. Accessing the environment to deploy sensors and subsequently collect sensor derived information can be costly even before taking into account the risk that data cannot be collected because the processing system fails to operate correctly with sensors measuring physical attributes of the ocean environment.

REFERENCES:
1. Jensen, Finn B.; Kuperman, William A.; Porter, Michael B; Schmidt, Henrik; Computational Ocean Acoustics, Second Edition. Springer, N.Y.: Springer Science+Business Media, LLC, 2011.

2. Biffl, Stefan; Aurum, Aybüke; Boehm, Barry; Erdogmus, Hakan; Grünbacher, Paul (Eds.), Value-Based Software Engineering. Berlin, Germany: Springer-Verlag Berlin Heidelberg, 2006

3. Boehm, Barry; Abts, Chris; Brown, A. Winsor; Chulani, Sunita; Clark, Bradford K.; Horowitz, Ellis; Madachy, Ray; Reifer, Donald J.; Steece, Bert; Software Cost Estimation with COCOMO II. Englewood Cliffs, NJ: Prentice-Hall, 2009.

KEYWORDS: Ocean sound propagation; Interface Simulation; Sonar Telemetry; Acoustic sensors; Acoustic Systems; electrical load simulation

N131-028 TITLE: Thermal Management Improvements for Transmit/Receive Modules

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: IWS 2.0 Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop bonding and sealing technologies for radar and electronic warfare (EW) Transmit/Receive (T/R) modules that achieve thermal management requirements for reliability, environment, endurance, and current assembly flows.

DESCRIPTION: Recent Defense Advanced Research Projects Agency (DARPA) and Office of Naval Research (ONR) Programs have developed thermal management technologies (Refs. 1-5) for Transmit/Receive (T/R) modules and assemblies. They have demonstrated significant improvements in thermal performance for current radar/Electronics Warfare (EW) programs. Thermal Ground Plane (TGP) vapor chambers have been developed to provide significant thermal spreading improvements. Additionally, NanoThermal Interface (NTI) technologies and materials significantly reduce z-axis thermal conduction from power amplifier devices into TGP thermal spreaders. However, innovative bonding and sealing materials to reduce costs while providing manufacturing process improvements to increase production are needed for TGI and NTI technologies to provide reliable operation over the life time of high power Radio Frequency (RF) systems and be usable in current assembly flows.

The Navy seeks innovative thermal bonding and sealing technology improvements to current radar/EW systems processes. The new processes can address either manufacturing or material changes to achieve the desired improvements. The technology must address reliability and manufacturing compatibility with current manufacturing flows while improving reliable thermal heat conduction from high power microcircuits to their heat sinks. Thermal resistance between the die-attach and the aperture should achieve a reduction of 25% over current standards.

Solutions should accommodate large thermal coefficient of expansion (TCE) mismatches between the device or carrier and the package, with the lowest thermal resistance performance attainable. The need for specialized polishing, oxide removal, or cleaning processes to facilitate rework and assembly, should be avoided. Solutions should also provide low cost, large area, hermetic RF packaging incorporating high effectiveness conductivity (>500W/mK) heat spreading base materials. Multi-piece RF package architectures with soldered or brazed RF and direct current (DC) feedthrus are preferred.

System constraints considered for the technology solution proposed will meet reliability requirements of shipboard Radar and EW systems. Operating conditions, thermal dissipation densities, operating temperatures, steady and transient state loads, 20-30 year life/reliability, and shipping and depot storage environments for maintenance support should all be considerations in developing the new technology.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort may require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for improved innovative thermal bonding and sealing technologies that meet the requirements described above. The contractor will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestone and, that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the thermal bonding and sealing technologies. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop the thermal sealing and bonding technology for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Thermal management technologies and manufacturing improvements developed under this topic will have direct application in commercial aperture systems used in communications and radar systems. These improvements can be used in applications such as Federal Aviation Administration (FAA) and communications industries.

REFERENCES:
1. Kenny, Thomas. “Thermal Ground Plane (TGP).” FedBizOpps DARPA-BAA-07-36. 16 April , 2007.<https://www.fbo.gov/index?s=opportunity&mode=form&id=108cf5f7bcd8591d17b87082ec7b164a&tab=core&_cview=1>

2. Kenny, Thomas “NanoThermal Interfaces (NTI).” FedBizOpps DARPA-BAA-08-42. 05 Aug , 2008.<https://www.fbo.gov/?s=opportunity&mode=form&tab=core&id=cd05c61fce5f278b899a6a8957cc7312&_cview=1>

3. Cohen, Dr. Avram Bar "Thermal Management Technologies (TMT)." Defense Advanced Research Projects Agency (DARPA) Microelectronic Technologies Office (MTO) Thermal Management Technologies (TMT) Website. 2012.
<http://www.darpa.mil/Our_Work/MTO/Programs/Thermal_Management_Technologies_(TMT).aspx>

4. Cai, Q., Chen, C-L., Xiong, G., and Ren, Z, "Explorations of Carbon Nanotube Wick Structure for High Heat Flux Cooling," Proceedings of the ASME Summer Heat Transfer Conference, Jacksonville, FL, 2008

5. Altman, D., Wasniewski, J., North, M., Kim, S., & Fisher, T. (2011). "Development of Micro/Nano Engineered Wick-Based Passive Heat Spreaders, Proceedings of the ASME." 2011 Pacific Rim Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Systems, MEMS and NEMS, IPACK2011-52122, 6-8 July, 2011, Portland, Oregon.

KEYWORDS: Thermal Ground Plane; NanoThermal Interface; Thermal Management; vapor chambers; Thermal Coefficient of Expansion; Electronic Warfare;

N131-029 TITLE: Anti-Jamming Capability for RT-1944/U Radio

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS420, LCS Mission Modules Program Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop an affordable solution that provides anti-jamming capability to the existing RT1944 Radio used for communication between Littoral Combat Ship (LCS) seaframes and the Unmanned Vehicle s (UVs) that constitute part of the LCS Mission Packages.

DESCRIPTION: The Littoral Combat Ship (LCS) Minecountermeasure (MCM) Mission Package (MP) will contain two types of unmanned vehicle to execute its mission: an Unmanned Surface Vehicle (USV) and a semisubmersible USV. The semisubmersible is the Remote Multimission Vehicle (RMMV), a snorkeling USV which is part of the AN/WLD-1 Remote Minehunting System (RMS). The Unmanned Surface Vehicles will be components of the Unmanned Influence Sweep System (UISS). The Multiple Vehicle Communications System (MVCS) provides the LCS MCM MP with the capability to simultaneously communicate with multiple RMMVs and USVs by providing common data link and network communication services.

The RT-1944/U radio has been selected for the current MVCS increment for Line of Sight (LOS) communications between the LCS and the RMMV and the Unmanned Influence Sweep UIS USVs. However, the radio lacks an anti-jamming capability, an important MCM MP requirement. Reference (1) provides information about the radio. Under this topic, the Navy seeks retrofit anti-jamming capability onto a radio that wasn't designed for it from the beginning. The requirement is important because hostile forces can use various radio jamming types such as Continuous Wave (CW) tone, swept CW tone, noise, clone signal, and transmitted pulsed signals to break the communications link to the unmanned vehicles by causing packet loss or preventing the receiver from being able to acquire or process any signals. To counter these types of threats, anti-jamming can be implemented by modifying the radio waveforms and installing directional antennas on the unmanned vehicles and, additionally, by using filters, which are required to allow multiple LCs seaframes to operate in the same area without co-site interference. References (2) and (3) are surveys of jamming and anti-jamming techniques provide useful overview information.

The MVCS requirement is that the radio system shall meet all performance specifications when an LCS sea frame and its unmanned vehicles are in a 30 dB Jammer/ Signal (J/S) power density environment, as measured at the antenna plane of reference, and with the jamming signal being a CW tone located at any point in the operating bandwidth of the radio system (2.2 GHz to 2.4 GHz). The performance shall be achieved over a minimum of 270 degrees of azimuth coverage. The objective requirement is when the LCS sea frame and unmanned systems are in a 36 dB J/S power density environment.

MVCS has directional antennas on the LCS sea frame but the RMMV and UISS have omni-directional antennas. The innovation required to replace the omni-directional antennas with directional antennas can include developing affordable phased array, null steered antennas for the two unmanned vehicles. A significant part of the innovation is doing anti-jamming in a packet based network. Most of the literature focuses on anti-jamming Global Positioning Satellite (GPS antennas) and assumes availability of a continuous transmitter that provides a signal to interference measurement whenever one is needed. In this case, a new packet needs to arrive in order to get an SNR measurement. Consequently, an antenna adaptation should not interfere with the basic functionality (control and coordination) of the network.

The MVCS currently does not have filters for jamming signals that are in the operating band of the RT-1944/U radio system (2.2 GHz to 2.4 GHz). Currently available filter technology provides banks of filters tuned to specific frequencies. These filters are large and expensive. The unmanned vehicles do not have the space for such filters. The innovation needed is an affordable filter tunable to different frequencies and small enough to be used on the unmanned vehicles.

Fully addressing the topic objective will likely require a multi-faceted approach. Proposals may address a total solution or components of a total solution; waveform modification; directional antenna; tunable filter. Other solutions that work in conjunction with these components will also be considered. Proposals should include the ant-jamming performance that will be gained from the anti-jamming technique(s) being proposed, and the modifications and additional weight required for the RMMV, UISS, and LCS sea frame. Solutions should be compatible with the requirements of the existing platforms and infrastructure.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for its proposed solution to prevent jamming of the MVCS radio used on LCS platforms, the RMMV, and UISS USV that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. The company will establish feasibility by performing an analysis of its design concept against an in band CW tone to determine the anti-jamming performance that the design will provide to the MVCS radio system. The company will also assess the feasibility of integrating the solution into the radio systems on the three platforms in terms of space, weight, and platform modification. The small business will provide a Phase II development plan that will address performance goals, key technical milestones, and technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop prototypes of its solution for evaluation on the three platforms to determine the solutions ability to meet the MVCS anti-jamming requirement, including the solutions ability t o operate within the total MVCS. The company will use the results to refine the prototype into a formal design suitable for a critical design review. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for MVCS use. The company will support PMS420 procurement, technology upgrades, integration, test, validation, certification, and qualification for implementation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Anti-jamming technology for wireless networks has applications in police, civil defense, search and rescue, and industrial use wherever critical communications can be intentionally or inadvertently interfered with.

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1. Harris Corporation. Documentation for SeaLancetTM RT-1944/U Radio. http://www.govcomm.harris.com/solutions/products/000122.asp. Downloaded 15 April 2012.

2. Kandangath, Anil. “Jamming Mitigation Techniques for Spread Spectrum Communication Systems.” http://www.ecogito.net/projects/download/proj_spwcomm.pdf. Downloaded 6 May 2012.

3. Mpitziopoulos , Aristides; Gavalas, Damianos; Konstantopoulos, Charalampos; and Pantziou, Grammati, “A Survey on Jamming Attacks and Countermeasures in WSNs.” IEEE Communications Surveys & Tutorials, Vol. 11, No. 4, Fourth Quarter 2009. Pages 42-56.

4. RT-1944/U SelAck Waveform, 3 pages (uploaded in SITIS 12/7/12).

5. RT-1944/U Technical Overview, 19 pages (uploaded in SITIS 12/7/12).

6. RSS P/N 224115 S-Band Bandpass Filter, 1 page (uploaded in SITIS 12/14/12).

KEYWORDS: anti-jamming; signal processing; spread spectrum; frequency hopping; directional antennas; waveform modifications

N131-030 TITLE: Multi-Static Processing Using Sonobuoys as Opportunistic Receivers

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEOIWS 5E, Anti-Submarine Warfare Command and Control Systems

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The object is to develop new processing algorithms to use sonobuoys as opportunistic multi-static receivers with other deployed active processing systems.

DESCRIPTION: The Navy has a need to extend the range and accuracy of existing sonar sensors; to increase warfighter capabilities by providing on-scene operators with more sonar options and courses of actions for Anti-Submarine Warfare (ASW) tactics; and to enhance platform inter-operability and coordinated ASW operations while ensuring that operators on the carrier and escort ships can view detection and tracking results on a common tactical picture. Successful development and fleet deployment of sonobuoy multi-static algorithms will improve ASW’s strike-group mission to better protect the carrier and escort ships from ASW threats. Sonar performance will achieve increased detection probability, increased detection range, increased submarine holding time, and increased success of submarine prosecution. Mission capability will be improved relative to the current system in which operators only have a mono-static option. A new technology will meet the need to improve performance and capability.

Sonobuoys provide the Navy with a unique capability as a remote sensor for ASW search and prosecution. There are two types of sonobuoys, passive and active. Passive sonobuoys, such as Frequency Analysis and Recording (DIFAR) Sonobuoys, are covert omni or directional receivers. They are used to Detect, Classify and Localize (DCL) threats. Active sonobuoys, such as the Directional Command Active Sonobuoy System (DICASS), are low power mono-static active sensors used for localization, tracking, and prosecution. Ref (1) describes current sonobuoy signal processing algorithms to improve detection, and resolve the bearing estimation ambiguity when processing widely spaced omni-directional sonobuoys arrays. Increasingly, coordination is required to manage the acoustic interference between Navy platforms to avoid false alarms in sonobuoy processing. This interference is caused by mutual acoustic interference from other active sensors (i.e. Surface combatant hull-mounted sonars, surface ship variable-depth active sonars, and helicopter-deployed Dipping sonars, such as the Airborne Low-Frequency Sonar (ALFS)).

The mutual acoustic interference described above can be used as a capability multiplier to perform opportunistic bi-static processing using a passive sonobuoy as the receiver and one or more cooperative active sources. Ref (2) highlights the performance potential of sonobuoys operating in a chokepoint in conjunction with a standoff sound source to create a barrier to submarine transit.

The Navy seeks acoustic processing algorithms that exploit multi-static active processing from sonobuoy receivers in conjunction with the cooperative active sources. The technology gap to be filled includes signal processing that uses the direct path pulse replica for both the matched filter processing and the timing basis to synchronize bi-static active source transmission with receiver processing as well as algorithms to exploit multi-static active processing with multiple sonobuoy receivers. The signal processing algorithms will be applied to systems with active or passive sonar systems (I.E. AN/SQQ-89, AN/SQQ-34, MH-60R, P-3).

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: Based on analysis of currently fielded active sonar systems and various passive and active sonobuoy receive bands, and candidate pairings of platform mounted active sonar and sonobuoy receivers, the company will develop a concept and conduct a feasibility analysis for bi-static processing, assuming the known locations of the transmitter and sonobuoy receivers and the time of pulse transmission. The company will generate an acoustic simulation of a source/receiver pairing and candidate processing algorithms as a proof of concept. The company will provide a Phase II development plan with performance goals, technical metrics, and key technical milestones. The development plan will address technical risk reduction for bi-static sonobuoy operations. The company will show feasibility of the technology development efforts and suitability of the technology for meeting Navy requirements.

PHASE II: Based on the results of Phase I algorithm assessments and the Phase II development plan, the company will develop a prototype system hosting the bi-static algorithms suitable for evaluation using calibrated simulator data and at-sea data recordings of sonobuoys and active sources. The company will measure prototype detection, localization, and tracking improvements relative to baseline monostatic sonobuoy performance. The results of this prototype assessment will be used to refine the processing algorithms, in order to support an evaluation of the capability using a government provided closed data set. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology into one or more ASW programs employing sonobuoys. Candidate transition programs include the aircraft carrier ASW combat system (CV-TSC), the MH-60R helicopter ASW system, and the AN/SQQ-89 surface ship ASW combat system. Specifically, the company will develop formal specifications, software, test documentation, and training support material necessary to complete the transition. Software for new algorithms and system interfaces will be developed in a distributed object processing framework implemented in the Java programming language. The company will tailor algorithms and system interfaces to be compatible with ASW systems on different platforms. The company will support the Navy and prime contractors for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A bi-static configuration of ultra-sonic sensors could be used for non-intrusive medical analysis where high-resolution object location and temporal analysis is needed. Also, acoustic security systems using low-power sources and fixed receivers with bi-static detection algorithms improve detection and localization accuracy against surface and subsurface objects

REFERENCES:
1. Osman, Abdalla; Noureldin, Aboelmagd. “Array Processing of Passive Sonobuoys for Underwater Target Tracking: Advanced Signal Processing Techniques.” LAP LAMBERT Academic Publishing, August 8, 2010.

2. Been, R., Jespers S.; Coraluppi, S.; Carthel, C.; Wathelet, A.; Strode, C., Vermeij, A. "Multistatic Sonar: A Road to a Maritime Network Enabled Capability." NATO Undersea Research Centre, Viale San Bartolomeo 400, 19126 La Spezia, Italy, October 2007.

KEYWORDS: Monostatic acoustic receiver; active sonar; passive sonar; bi-static sonobuoy, multi-static sonobuoy, detection, localization, and tracking

N131-031 TITLE: New Radar/EW Transmit/Receiver Modules and Assemblies Technologies

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The object is to develop technology for Transmit/Receive Modules through improvements to their assemblies for legacy shipboard radar/EW systems that achieve technological improvement and form fit function replacements.

DESCRIPTION: Innovative approaches to replace or reduce the costs of T/R Modules and assemblies are needed to reduce total ownership cost for shipboard radar/EW systems. Integrating new technologies would decrease costs to the Navy and improve the sustainment of legacy systems. Transmit and Receiver (T/R) Modules (Ref. 4, 5) and assemblies make up a large percentage of the new radar and Electronic Warfare (EW) apertures under development. They represent 30-80% of the radar cost, depending upon the number of elements used. They are constructed with high cost Wide Band Gap (WBG) devices and expensive supporting components. There is a need to lower the cost of Navy radar apertures by addressing costs associated with T/R modules and assemblies.

The existing assemblies (Ref. 1, 3) used in T/R modules are made up of costly ceramic and metal technologies. They use Gallium Nitride (GaN) and Gallium Arsenide (GaAs) Monolithic Microwave Integrated Circuits (MMICs) (Ref. 2). The MMICs are 30-60% of the total cost of the T/R modules. Optimum use of alternative technologies such as silicon (Si) and silicon germanium (SiGe) will provide significant cost reductions over existing solutions if the technologies can be developed to satisfy shipboard radar and EW system requirements. Alternatives are needed that will reduce the cost of the electronic assemblies by a factor of 3-5 compared to existing technologies. Replacement technology must reduce life-cycle costs and maintain Navy system performance.

Current T/R modules and their assemblies are not only costly, but they are generally proprietary to the providers. The Navy is seeking to reduce costs, promote commonality across system interfaces, and establish open systems sources for aperture component technologies by replacing current T/R modules and assemblies. Savings will increase by utilizing common system building blocks and associated technologies when replacing existing modules and assemblies as they fail, and establish broader supply sources for maintaining apertures.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The contractor will develop concepts to replace T/R modules and assemblies that meet the requirements described above. The contractor will demonstrate the feasibility of the concepts in meeting Navy needs and will establish the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material and/or design element testing and analytical modeling. The company will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype T/R module and assembly for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan. System performance will be demonstrated through prototype evaluation, modeling, and analysis over the required range of parameters and needed deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a T/R Module or assembly replacement for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Utilization of lowest cost components in aperture radar/EW systems will benefit commercial and other government programs using aperture based systems such as automotive collision avoidance and cruise control, communications, weather avoidance, navigation, and maritime surveillance radar systems

REFERENCES:
1. Tummala, R. R., Editor. “Microelectronics Packaging Handbook”, 3rd Edition, Kluwer Academic Publications, 2004.

2. Fisher, Dennis. “Gallium Arsenide IC Applications Handbook Volume 1”, Academic Press, 1995.

3. Johnson, R.W. Editor. “Multichip Modules”, IEEE Press, 1991

4. Richards, Mark A., Scheer, James A., Holm, William A. Principles of Modern Radar: Basic Principles. SciTech Publishing Company. 2010

5. Kopp, Bruce A.; Borkowski, Michael; Jerinic, George “Transmit/receive modules.” IEEE Transactions on Microwave Theory and Techniques. 2002, vol. 50, Issue 3, pp. 827-834

KEYWORDS: MMIC; electronic warfare(EW); Wide Bandgap; T/R module; gallium nitride(GaN); gallium arsenide (GaAs);Silicon Germanium SiGe; aperture

N131-032 TITLE: Low Noise Torpedo Power Supply

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMS404, Undersea Weapons Program Office

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OBJECTIVE: The objective is to develop and field an innovative power supply that supports the extremely low noise requirements of a broadband torpedo sonar system.

DESCRIPTION: The Navy has developed a broadband sonar system for the Mk48 Heavyweight Torpedo with a significantly widened signal processing bandwidth to improve performance and capability over the legacy sonar system. The broadband sonar system, however, cannot operate to its full potential due to noise and ripple from the current power supplies used to supply power to the electronics in the torpedo.

The current technology used for power supplies in the commercial and government sector is linear and switching (See reference 1). For the past ten years the method used to supply the power to the electronics in the torpedo has been commercial off the shelf switch mode DC-DC converters which have a slight disadvantage of producing radiated EMI (electrical noise).

As the Navy pursues improvements in torpedo performance with state of the art sonar systems, power supply performance for these systems will need to improve. An extremely low noise, low ripple power supply capable of rejecting noise generated by the torpedo is required for the broadband sonar system (See references 2and 3). The power supply will have an input voltage of 275VDC supplied by the torpedo and shall perform a DC to DC conversion to generate low output voltages ranging from 3.3VDC to 28VDC with an output noise less than 0.15mVrms/rtHz and shall be capable of providing an output power of approximately 1275 watts. The power supply shall reside in a volume of 225 cubic inches and weigh less than 13 lbs.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for an improved Low Noise Torpedo Power Supply that meets the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The company will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the low noise power supply. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including in-water demonstrations. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will work with the Navy conducting tests and in-water demonstrations using the improved power supplies installed in torpedoes. The in-water testing will verify the performance of the selected concept and allow for ease of transition into torpedoes requiring the improved power supplies. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These state of the art power supply concepts could be used in avionics, vetronics, medical imaging and pro/commercial audio applications (i.e. Scanning Electron Microscope (SEM)).

REFERENCES:
1. Brown, Marty. Practical Switching Power Supply Design (Motorola Series in Solid State Electronics). San Diego: Academic Press, 1990.

2. Self, Douglas. Audio Power Amplifier Design Handbook, 5th Edition. Burlington: Elsevier Ltd., 2009.

3. Brown, Marty. Power Sources and Supplies: World Class Designs. Burlington: Elsevier Ltd., 2008.

KEYWORDS: Linear Regulated Power Supply Switched-Mode Power Supply; Line Regulation; Ultralow Noise Regulators; Power Supply Rejection; Distortion; Sonar; Noise Reduction (filtering), and Dynamic Range

N131-033 TITLE: Submarine Radar Vulnerability Reduction

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS435, Integrated Submarine Imaging System, ACAT IV

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop radar reduction technology for a panoramic imaging submarine mast that has multiple optical windows.

DESCRIPTION: The Navy is developing a new panoramic imaging submarine mast which will be similar in size to existing submarine periscopes for which general information is widely available. (See Reference 1.) Current technology covers masts with radar absorbing material structure, allowing an unobstructed area for the optical window. The architecture of a panoramic mast is vastly different from the existing masts, and requires a new innovative approach to implement and improve this radar absorbing capability. There are two critical differences between the standard periscope mast and the new panoramic mast: (1) the panoramic mast has multiple windows, which will affect the structural integrity of the resulting radar absorbing material to be attached to the mast (with less surface area, it must be stronger than existing products which cover a whole mast), and (2) the panoramic mast has multiple windows which must have their individual signature contributions mitigated, providing a considerable challenge to develop a new capability over what is currently available. Existing state-of-the-art microwave absorbing technology includes various types of composites or coatings used for shielding against electromagnetic interference, antenna development and pattern shaping, and dielectrics. (See References 2, 3 & 4.) The Navy desires a solution that must provide radar vulnerability reduction for both the mast and the optical windows. It must remain attached while the mast is in the vertical position and raised above the submarine sail. It must be survivable while exposed to high pressure salt water for extended durations. Pieces mounted on the outside of the mast can be up to 3/4 inch thick, and pieces or coatings over the optical windows must be optically transparent. The product may be one physical piece, or multiple components (necessary, for example, if coatings on windows were used).

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for signature reduction technology that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for signature requirements. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop signature reduction technology for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial use of this technology includes electromagnetic interference reduction in electronic devices, particularly mobile devices which have microwave transmitters. In addition, absorbing materials can be used to control antenna patterns in radar detectors or microwave communications devices (cellular or satellite).

REFERENCES:
1. Kollmorgan Optronic Products, 2012, <http://www.eo.kollmorgen.com/productlines/optronics/>

2. "Absorbing Materials", Microwaves101.com, 2012.
<http://www.microwaves101.com/encyclopedia/absorbing.cfm>.

3. Micheli, Davide; Apollo, Carmelo; Pastore, Roberto; Morles, Ramon Bueno; Marchetti, Mario; Gradoni, Gabriele, "Electromagnetic Characterization of Composite Materials and Microwave Absorbing Modeling", University of Rome, April, 2011. < http://www.intechopen.com/books/advances-in-nanocomposites-synthesis-characterization-and-industrial-applications/electromagnetic-characterization-of-composite-materials-and-microwave-absorbing-modeling>.

4. Stephan, Scott, Laird Technologies, “Microwave Absorbers: Common Uses and a Comparison”, December 2008. <http://www.conformity.com/artman/publish/printer_feature266.shtml>.

KEYWORDS: Microwave absorbing; panoramic mast; submarine vulnerability; radar absorbing material; composite materials; optical coating

N131-034 TITLE: <u>Improved Anti-Corrosion Coatings for Undersea Cable Connectors</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS450, VIRGINIA Class Submarine Program Office

OBJECTIVE: Advance the state of the art in anti-corrosion coatings to develop a robust nonconductive coating suitable for bonding to various connectors in the outboard environment.

DESCRIPTION: Outboard cabling connectors in Navy Submarines are continually exposed to a harsh saltwater environment. Nonconductive coatings, such as those described in [7], are used to extend the service life of outboard connectors. This SBIR will investigate, develop, and demonstrate a new generation of corrosion resistant coatings for outboard connector applications. It is anticipated that advanced anti-corrosion coatings could have a major impact in extending the service life of outboard connectors and cables. Currently, the application of anti-corrosion coatings is limited to flat or cylindrical surface geometries due to the need for uniform coating thickness [6]. There are a large number of outboard connector types in Navy Submarines that are unable to be coated using current technology. A coating material and/or process that is applicable to more complex surface geometries is highly desirable. Connectors may also have vulcanized rubber over-molds, which coatings are currently not applied to. Relevant advances in coating technology [1,2,3,4,5] indicate it may be possible to develop a coating material and/or process suitable for more complex surface geometries and rubber over-molds. The technology developed by this SBIR will be capable of coating, with uniform thickness, surfaces with 90 degree angles. Surface materials may consist of Monel, 316 stainless steel, titanium, and vulcanized rubber. Technologies of interest include, but are not limited to, deionizing plasma coatings and nonfriction plasma coatings.

PHASE I: The company will develop concepts for advanced anti-corrosion coatings that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. By the conclusion of Phase 1, identify which concepts will be pursued in subsequent phases. The company will provide a Phase II development plan with performance goals and key technical milestones, and will address technical risk reduction.

PHASE II: Based on the results of Phase 1 and the Phase II development plan, the company will develop a prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals as defined in Phase II development plan. Coating performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles in the outboard submarine environment. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a prototype suitable for installation aboard a US Navy Submarine. Develop materials, drawing packages, manuals, and documentation to aid in installation and testing of prototypes shipboard during extended operational periods. Conduct all required conformance testing. Support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential applications for an anti-corrosion coating that is compatible with complex surface geometries are numerous. The technology developed in this SBIR could potentially be used anywhere corrosion control is required. This could include maritime structures, commercial shipbuilding, and civil / environmental engineering applications (such as [2]).

REFERENCES:
1. Poon, R.W. “Improved Corrosion Resistance of Plasma Carbon Coated NiTi Orthopedic Materials.” Plasma Science, 31st IEEE International Conference on. July 2004.

2. Liu, H. “Research on Preparation and Properties of Multi-Function Anti-Corrosion Coating used to Inner Wall of Water Pond in Service Area of Express Highway.” Remote Sensing, IEEE International Conference on. June 2011.

3. Nie, X. “Abrasive Wear / Corrosion Properties and TEM Analysis of Al203 Coatings Fabricated using Plasma Electrolysis.” Surface and Coatings Technology 149. January 2002.

4. D. Greenfield and F. Clegg, "Enhancement of Barrier Properties in Organic Coatings Using Nanocomposites", Journal of Corrosion Science and Engineering, 8, 8 (2004)

5. W.J. van Ooij et al., "Silane-based Chromate Replacements for Corrosion Control, Paint Adhesion, and Rubber Bonding", Surface Engineering, 16, 386 (2000).

6. A.L. Bray and C.P. Thornton, "Phase II SBIR Final Technical Report: Non-Conductive Coatings For Underwater Connector Backshells", SBIR Phase II Report, Contract Number N00024-93-C-4124, (1995).

7. Naval Sea Systems Command. “S9320-AM-PRO-030/MLDG: Plasma Spray Procedure.” Technical Manual, Underwater Cable and Encapsulated Components Fabrication, Repair, and Installation Manual. Volume II.

KEYWORDS: Corrosion; Nonconductive Coatings; Plasma Coatings; Deionizing Coatings; Vulcanized Surfaces; Submarine Outboard Cables

N131-035 TITLE: <u>Anticorrosion Solution for Remote Minehunting System (RMS) Tow Cable.</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS403, Remote Minehunting System Program Office

OBJECTIVE: The objective is to develop an anticorrosive coating or other effective anticorrosion solution for the Remote Minehunting System tow cable that achieves requirements of long-term durability and robustness in harsh marine operational conditions.

DESCRIPTION: The Remote Minehunting System (RMS), as described in Reference 1, is composed of the semi-autonomous semi-submersible Remote Multi-Mission Vehicle (RMMV) coupled with the towed AN/AQS- 20A mine-hunting sonar system. The RMS is launched and recovered from both variants of the Littoral Combat Ship (LCS) seaframes to perform mine countermeasure (MCM) missions. Stainless steel tow cables, used to tow the AQS- 20A from the RMMV, are experiencing early life corrosion due to excessive salt water deposit buildup that occurs over repeated operations and subsequent system stowage. The tow cable strands are made from Nitronic 50. In operational use, the RMMV streams the AQS- 20A, during which the tow cable experiences significant bending and abrasion as it is unwound from the stowage drum and passes over a traction drive and tow sheave. Upon completion of a minehunting operation, the RMMV retrieves the AQS- 20A by winding the tow cable back through the tow sheave, traction drive, and onto the stowage drum. The RMS is recovered and removed from the seawater. The RMS is then stored, leaving the tow cable to dry on its stowage drum on the RMMV without the salt water or its deposits being cleaned from the cable. Consequently salt deposits build up on the tow cable, producing corrosion and tow cable failure, potentially resulting in AQS 20A damage or loss during a subsequent operation. Freshwater washing of the unwound tow cable is not practical during rewinding or in between operations, due to constraints on space, manpower, and freshwater availability that would be required to unwind and wash the cable.

Although this topic focuses on anticorrosion coatings, proposals for other effective solutions that maintain the current cable system and meet the specific goals of the topic will be considered. Current state of the art anti-corrosion coatings are intended to treat solid, flat, and unbendable surfaces, such as ship hulls and bulkheads. Also, current anti-corrosion coatings for cable application are not designed for significant bending, abrasion, and seawater flow operations. The innovation desired is an anti-corrosion solution, like the generalized solutions discussed in References 2 through 4, which is able to withstand the rugged environment of being repeatedly submerged, abraded, bent, wound, unwound, and towed through seawater without degradation. The solution should be long-lasting, durable, and robust. An effective barrier between the deposited salt and the tow cable will lead to increased tow cable life, resulting in cost savings and reduced risk of losing or damaging the towed AQS- 20A during operations. The solution must address the current stainless steel cable; proposals for protecting cable strength members other than Nitronic 50 will be deemed non-responsive. Reference 5 provides additional information important to understanding the problem and to developing potential solutions.

PHASE I: The company will develop concepts for the anti-corrosion solution for the RMS tow cable that meet the topic objectives. The company will demonstrate the feasibility of the concepts in meeting the objectives and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and simulations of the coated tow cable. Feasibility analysis shall be documented in a final report. The report shall outline the proposed anti-corrosion solution and capabilities, as well as any experimental and modeling results. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will produce a prototype anti-corrosion solution for evaluation in a laboratory environment. The solution will be evaluated by the company to determine its capability in meeting the performance goals defined in Phase II development plan and Navy requirements. The company will develop a procedure to apply or integrate the coating or other effective solution. The company will demonstrate performance through accelerated testing and simulation of numerous cable deployment cycles in conditions equivalent to those it would experience in actual operation. The company will use the evaluation results to refine the product and application or integration. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an integration plan for use in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the anti-corrosion solution for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Corrosion remains a large and costly problem in the military as well as the commercial sector. The petroleum industry, research institutions, and fishing industry all experience costly repairs and equipment downtime due to corrective maintenance caused by corrosion of marine tow cable equipment. Extending the life of their tow cables by using a long-lasting and robust coating or other effective solution that minimizes or eliminates the need to reapply it will significantly reduce costs and minimize risk. In addition, the coating could have broader applications than to just tow cables.

REFERENCES:
1. “Remote Multi-Mission Vehicle (RMMV) Fact Sheet.” Department of the Navy Research, Development, and Acquisition. Program Executive Office, Littoral Combat Ships (PEO LCS), 29 February 2012 <https://acquisition.navy.mil/rda/home/organizations/peos_drpms/peo_lcs/pms_403>.

2. “Corrosion Protection of Steel.” Keys to Metals. 01 March 2012 <http://www.keytometals.com/page.aspx?ID=CheckArticle&site=kts&NM=300>.

3. Wood, Herbert T. “A Survey of Publications Dealing with Corrosion in Wire Rope.” Defense Technical Information Center. January 1971. The Catholic University of America. 8 May 2012 <http://www.dtic.mil/dtic/tr/fulltext/u2/725134.pdf>.

4. “Wire and Fiber Rope and Rigging, Naval Ships Technical Manual, Chapter 613”. Naval Safety Center. Naval Sea Systems Command. 1 July 2008 (Revision 4). 9 May 2012 <http://www.public.navy.mil/navsafecen/Documents/afloat/Surface/DckAr/D_Ref/613WireRig.pdf>.

5. "Additional Guidance for Anticorrosion Solution for Remote Minehunting System (RMS) Tow Cable," posted in SITIS 11/27/12

KEYWORDS: Steel corrosion protection; hydrophobic coating; Remote Minehunting System; marine tow cable; anti-corrosion materials and coatings; Nitronic 50

N131-036 TITLE: Automated Generation of Electronic Warfare Libraries

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop technologies that automate the creation of Electronic Warfare (EW) emitter libraries and that will correctly identify and classify threat candidates.

DESCRIPTION: The process of generating Electronic Warfare (EW) libraries for current EW systems is a labor intensive and time consuming task because of the metrological differences between the various Electronic Intelligence (ELINT) collection systems and the tactical EW systems. The key parameters measured by ELINT systems are frequency, pulse width; scan type, pulse repetition interval (PRI), range of frequency, PRI stagger type, and others. The parameters are measured with great precision and numerous measurements, in order to gain statistical fidelity when compared with tactical EW systems. Tactical EW systems make classification decisions with a comparatively sparse set of parameters and number of measurements. Consequently they have less accuracy and lower statistical fidelity. This requires the tactical EW libraries that are derived from the national ELINT library databases, to be uniquely tailored or "colorized" to optimize the correct classification of the detected threat. A tool set is needed that automatically resolves the metrological differences of national ELINT systems compared with tactical EW systems. Currently there are no viable options to EW libraries. The tool set would reduce manning costs and prevent the recurring costs associated with engineering a new solution each time.

Current "coloring" processes require human interfaces to manually generate emitter scenarios, insert the scenarios into the EW system, note the outputs, and then modify or "color" the library parameters so as to produce a system output that corresponds to the input emitter. This "coloring" process is time consuming, and does not always provide the mathematically optimal and lowest ambiguity emitter correlation. An automated methodology will perform the process more efficiently and optimize the solution in a multi-dimensional space and produce the correct identification with the lowest ambiguity in the required tactical response time (Ref. 1, 2, 3). The Navy is seeking innovative analysis tools that are more encompassing than currently available tools as the amount of specialized data becomes larger and much more complicated in its relationships.

The Navy has an urgent need to automate the generation of EW threat libraries to reduce the current labor intensive costly manual process which is inefficient and leads to inaccuracy in threat classification results. Automation will reduce costs and improve EW performance, greatly improving ship and battle group self-defense. The development of this EW tool set will provide the Navy a way to efficiently map existing sensor data into the tactical EW systems, preserve data from loss, and automate the processes that are used to update the EW threat libraries.

High Level Program Requirements:
1) The software product shall read the raw data files and create a EW Library File that can be installed and used in an operational environment.
2) The software product shall run on standard PC computers.
3) The software product shall modify raw data to match emitter data.
4) The software product shall have a GUI interface.
5) The company shall deliver a user manual electronically.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop innovative software algorithms and computing methods for automating EW library generation described above. The company will demonstrate the feasibility of the algorithms and methods to meet Navy needs and will show the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be shown through testing and analytical scenarios implemented in a simulated environment. The small business will provide a Phase II development plan with performance goals and key technical milestones, and will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype process for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the new automated EW library generation. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements of a more efficient and reliable library development tool. The company will prepare a Phase III development plan to transition the technology to Navy use. The company will be provided with suitable test data and have access to Navy facilities as required.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the automated EW library tool set for Navy use. The company will evaluate the refined prototype tool set to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the tool set for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Radar and combat systems use similar library structures and require similar tools to tailor the tactical systems from national databases that have similar metrological differences. There is potential to use this technology in marine, automotive, and space systems commercially that require the comparison of low quality measured data to higher quality standardized data.

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KEYWORDS: Metrology, Electronic Warfare, Electronic warfare libraries, Electronic Intelligence (ELINT) Operational Shipboard Electromagnetic Environment, Electronic Order of Battle, Situational Awareness.

N131-037 TITLE: Innovative Algorithms for the Categorization of Mine-Like Objects Using Standard Sonar Return Data.

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS495, Mine Warfare Program Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop signal processing techniques that are compatible with Commercial-off-the-Shelf (COTS) active sonar systems and complement existing algorithms by categorizing underwater mines and mine-like targets.

DESCRIPTION: Commercially produced active sonars for detecting and classifying mine-like objects are used on a variety of Navy platforms ranging from diver hand held sonars, Unmanned Underwater Vehicles (UUVs) and Unmanned Surface Vehicles (USVs), surface ships and submarines, to helicopters. Reference (1) provides an overview of such sonars. The primary transition path for the technology developed under this topic is active sonars for Mine Countermeasures (MCM) systems within the Program Executive Office (PEO) for Littoral Combat Ships (LCS). Reference (2) is a snapshot of such systems. Successful algorithms will also be of strong interest for use by Navy Expeditionary UUV sonars. Reference (3) provides general information about these systems. In either case, the first application will depend on the COTS sonar a successful offeror under this topic selects for demonstration of its algorithms. For a sonar such as the AN/SQQ-32(V)4 High Frequency Wide Band Sonar operator assessment of sonar returns occurs on an in-service processor contact display system. For other sonars, such as the AN/SQQ-32 V(4) Minehunting Sonar System and Expeditionary UUV sonars, operator assessment of returns occurs using standard commercial imagery review products on Post-Mission Analysis (PMA) stations with potential long-term use in real-time or near-real-time assessment of targets. The expectation is that algorithms successfully developed and demonstrated under this topic will be adaptable to use with other COTS sonars. In Phase II of this SBIR the specific interface requirements will be addressed for the primary transition applications.

The key ingredient to any sonar detection and classification capability is the ability to properly classify the target of interest while eliminating false targets. Achieving this capability becomes much more difficult for smaller targets, such as mines and mine-like objects, in the littoral zone where clutter provides a large number of objects that lead to false alarms. Current state-of-the-art sonar systems use frequency and echo return data to provide a size and distance calculation. Standard signal processing techniques and algorithms in COTS sonars are used to identify and categorize objects based predominantly on image shape, size, and key external features. The limitation of this approach is that, generally, sonar identification and classification algorithms exploit specular and diffractive scattering of sonar signals reflecting off objects, but the active acoustic response is similar whether those objects are targets or false targets. High False Alarm rates require operators to take multiple looks at multiple objects on sonar displays, slowing operational tempo considerably. Though additional information can sometimes be gained by examining shadows from these returns, the ability to get more information from COTS image-based sonars, beyond just external shape, would very valuable and would offer a means of enhanced classification and reduced false alarm rates. Resolution underwater using sonar is very limited. For this reason today's sonar systems can provide only contact location and a preliminary contact type decision of "mine like" or "non mine like". Even COTS Synthetic Aperture Sonars (SAR) could benefit from the algorithms developed under this topic. Reference (4) is a review of SAR sonar state of the art.

This effort should focus on exploiting sonar returns to allow more definitive discrimination between actual and false targets. If successful, this technology will support the decision to change a "mine-like object" classification to "identified mine" or "not a mine." The technological innovation required is to use the acoustic sensor data from COTS sonars to capture attributes of a targets not currently provided by the sonars' standard algorithms, so that the captured attributes complement the imagery provided by the standard algorithms, thereby aiding the operator in reducing false targets.

The proposed technology effort must identify the physics of the scattering mechanism(s); this will yield clues on how to exploit the data, how to exploit signal processing, as well as clues on how to adjust and optimize the interrogating waveform. It should be implementable with minimal impact on existing sonar systems, including user interfaces and displays to keep this complementary system enhancement affordable. The algorithms, preferably, should be applicable to sonar data that has been preprocessed to an extent as opposed to requiring raw data. The state of the data, raw or pre-processed, will depend on the COTS sonar selected for demonstration. Offerors are expected to obtain acoustic data from the manufacturer of the selected sonar. Although offerors are not required to identify specific COTS sonar until the Phase II development plan provided under the Phase I effort, they are strongly urged to consider this decision during Phase I proposal preparation. Companies should demonstrate in their proposals an understanding of what is necessary to bring the technology from the laboratory to integration into an operational sonar system. This understanding is important to minimizing the cost of that impact and may inform the development of the algorithms.

Proposals for Low Frequency Broad Band sonar algorithms will not be funded under this topic since the Navy is already substantially investing in this area. High frequency sonar units, for example those greater than 200 Kilohertz (KHz) are of particular interest. The AN/SQQ-32(V)4 High Frequency Wide Band Sonar would be one of the Phase III transition paths PEOLCS will seriously consider for technology successfully developed under this topic, though offerors are not required to select this COTS sonar in Phase II.

The Phase I effort will not require access to classified information. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will focus on concept development and feasibility defining the physics of this technique, establishing and documenting the algorithm models, and clearly describing the exploitation methodology and theory used independent of frequency. The company will define initial innovative, proof-of-concept algorithms for processing returns from existing sonars to provide additional information about the target beyond that provided by standard sonar signal processing techniques. To demonstrate proof-of-concept, the algorithms should, at the minimum, categorize targets as to "mine-like" or "not mike-like." The company will develop the theoretical underpinnings of the proof-of-concept algorithms and develop a detailed explanation of how the algorithms complement those used in current COTS sonars. The company will use representative data to evaluate laboratory physics models of the algorithms The company will provide a Phase II development plan identifying a specific COTS sonar and including with performance goals and key technical milestones that will address technical and integration risks

PHASE II: Based on the results of Phase I algorithm assessments and the Phase II development plan, the company will further develop, test, and validate algorithms to Technology Readiness Level (TRL) 5 using data from the selected COTS sonar. The company will evaluate the algorithms against criteria to include: (1) the dependence of the algorithms on such factors as range, grazing angle, azimuth relative to target orientation; (2) the algorithms' speed to solution; (3) the effect on algorithm success of marine growth on targets; (4) the adaptability of the algorithms to the COTS sonar. The company will explain the next steps required, including development of a user interface and compilation of a library of results. The company will define the path to bring the, needed components and algorithms to Technology Readiness Level 7. The company will provide an estimate on the processing and data storage requirements necessary to accommodate integration of these algorithms as complementary information to the still required traditional sonar data processing and storage. The explanation should include preliminary cost and time estimates. The company will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: If the Phase II is successful, the company will complete the development and testing of the algorithms to TRL 8 and will develop the user interface and library. The company will be expected to support the Navy in the implementation of the algorithms on a fielded Navy–identified post-mission analysis system. The company will support the Navy or the manufacturer of the COTS sonar for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Using sonar to distinguish mines from similar objects in clutter is a subset of a more general capability to distinguish among and categorize objects. This capability has applications in several activities which use side scan sonar to search or survey underwater areas. Examples include: looking for wreckage or a black box after a plane crash; assessing clutter on the bottom of a harbor prior to cleanup or for homeland security; carrying out underwater archeological or oceanographic research.

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KEYWORDS: minehunting sonar; sonar algorithms; mine-like objects; Littoral Combat Ship; Mine Coutermeasure Mission Package; Expeditionary minehunting UUVS

N131-038 TITLE: <u>Shipboard Software Deployment Tools for Complex Heterogeneous Systems</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO-IWS-5A Advanced Systems and Technology Office.

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop automation tools and techniques for software deployment and installation on complex heterogeneous systems, which improve reliability of network configuration and system interfaces, and decrease system down time.

DESCRIPTION: Navy Combat Systems are complex, network-based collections of heterogeneous software components from multiple vendors. The complexity and heterogeneous nature of these systems make initial software deployment time consuming and error prone. Worse, shipboard personnel are frequently required to redeploy software after the initial Installation and Checkout (INCO) due to hardware or system failures and in the event of system attack or corruption.

Current software installation tools and processes do not adequately address the environment of the complex systems. They often address a partial ability to make the needed installation, leaving the rest of the installation to manual processes and procedures. Current components include executables, firmware, or data in various forms such as databases, flat files, or configuration files. The components are often hardware specific or dependent. The number of discreet steps a sailor must accurately perform to properly redeploy system software is overwhelming, often resulting in a flawed installation and reduced system performance.

Technological concepts, products, methods, and techniques are needed to develop procedures that allow shipboard operators to consistently and successfully perform complex heterogeneous system software installations of an Anti-Submarine Warfare (ASW) system in remote situations. The technology sought will support the operators of the AN/SQQ89A (V)15 sonar system. The technology will involve interaction between LINUX, Solaris, and Fedora Core software. The installations have to be accomplished without the aid of highly trained system experts (Ref. 2). A person-to-machine interface that supports operator problem-solving and decision-making situations, without requiring detailed knowledge of underlying software components, network architecture or system interfaces is needed. Meeting this need will provide improved performance and capability.

Software deployment can be categorized by six activities: Release, Install, Activate, Deactivate, Update and Adapt (Ref. 1). This topic solicits innovation for the Install, Activate, and Deactivate activities. Install activity covers the transfer from producer to consumer and the installation at the consumer site. Activate and Deactivate cover initialization and shutdown of the software, respectively.

Current processes and tools for streamlined software installation and deployment concentrate on deploying software systems from commercial vendors to commercial customers. Most of the technologies concentrate on medium to large size commercial organizations deploying software across wide area networks (WANs) or via remote deployments such as cloud computing. These processes and tools are not designed with specific combat system concerns and obstacles in mind. They require a high level of system administration expertise and dedicated system administration resources (Ref 3). Shipboard combat systems present a unique complicated challenge to system and software deployment. They are on mobile, sea going, combat vessels that have to meet the safeguards and restrictions imposed by Security and Information Assurance requirements. Additionally, ample storage is not available for spare resources, redundant components, backup systems, or alternative processing facilities. More importantly, shipboard combat system operators do not have the same level of training and experience, nor do they have expert support personnel available (Ref 4).

Fleet support agencies or contractors are generally responsible for the Release, Update, Adapt, and initial Install activities. In cases of system failure, shipboard personnel, have to perform the Install activity. Of these, install is the most complex of the software deployment activities and must be accomplished without the training, experience, or support that is available to commercial organizations. The proposed processes and tools would have to automate the Install activity for an ASW system and facilitate the system software redeployment without the need for detailed knowledge of system software components, operating systems, network architectures, or system interfaces. This tool will provide the Navy with the needed improved performance and capability.

The Phase I effort does not require access to classified information. Data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certifications for handling classified data.

PHASE I: The company will develop concepts for Shipboard Software Deployment Tools that meet the requirements described above The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by analysis of their design approach. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype that can install a representative fragment of a full Anti-Submarine Warfare system for evaluation as appropriate. The prototype will be evaluated to determine its capability to meet the performance goals defined in the Phase II development plan and the Navy requirements for Shipboard Software Deployment Tools. System performance will be demonstrated through prototype evaluation, modeling, or analysis over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the tool for Navy use. The company will develop Shipboard Software Deployment Tools for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any industry that deploys software. Current state of the art for commercial systems is to deploy renditions of operating systems across multiple computing hardware platforms. They have multiple operating systems and multiple hardware systems that must have configurations that meet stringent corporate standards for protecting their businesses and their proprietary information. The use of this tool would reduce the time involved and the needed expertise to oversee deployment of their computing environments.

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KEYWORDS: System Interfaces, software installation and deployment, software deployment activities, shipboard combat systems, system software redeployment, redeploy software

N131-039 TITLE: Aerostat Communications Relay from Unmanned Surface Vehicle

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS420, LCS Mission Modules Program Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to increase the communications range between the Littoral Combat Ship (LCS) seaframes and Mission Package Unmanned Surface Vehicles (USVs) by developing a modular aerostat communications relay system for the RT-1944/U radio that is semi-autonomously deployed and retrieved from the LCS Unmanned Influence Sweep System USV. The modular aerostat communications relay system includes an aerostat with the RT-1944/U radio, and a launch and recovery mechanism.

DESCRIPTION: The Navy Littoral Combat Ships (LCS) Minecountermeasure (MCM) Mission Package (MP) will include the Unmanned Influence Sweep System (UISS). Reference (1) provides an overview of the UISS. A key component of UISS will be a light-weight, high- speed Unmanned Surface Vehicle (USV) which will sweep minefields ahead of the underway LCS seaframes. Reference (2) contains high level descriptions of the UISS USV. The LCS platforms and the USVs will communicate with each other through the Multiple Vehicle Communications System (MVCS) which gives LCS MPs the capability to simultaneously communicate with multiple Unmanned Vehicles (UVs) by providing common data link and network communication services.

The RT-1944/U radio has been selected for the current MVCS increment for Line of Sight (LOS) communications between the LCS and the UISS USV. The radio will also be used for the next increment which includes an Over the Horizon (OTH) communication requirement between unmanned vehicles and the LCS platforms. Reference (2) provides details about the radio. The current plan is to use helicopters and Vertical Take Off Unmanned Air Vehicles (VTUAVs) for the OTH relay links between unmanned vehicles and the LCS platforms. Both of these links have the disadvantage of limited time on station because of fuel consumption. In addition, a helicopter is a costly resource to use for a relay link, especially when it could be performing other missions. It is highly desirable to provide Over the Horizon (OTH) communications for a longer period of time than can be achieved with Unmanned Aerial Vehicle relays. For the next increment, and perhaps longer, no satellite communication solution is expected to be available that can support the MCM MP data rate requirement. Similarly, no antennas currently exist that are small enough to fit on unmanned vehicles and support the bandwidth required for satellite communication. Craft close to the water and subject to wave motion pose additional challenges to antenna design. Furthermore, military demand for satellite communications is high and will be provided on a priority basis.

Consequently, an aerostat tethered to the UISS USV has been identified as a desirable solution for OTH communication with the LCS seaframe. Previous Navy investigation has indicated that an aerostat solution is feasible and that significant innovation will be needed to achieve it. Currently, no aerostat or similar tethered vehicle has been identified that is small enough or stable enough to be launched from a USV while carrying the radio. Once launched from the USV, an aerostat carrying the radio has the potential to provide a long term direct link to the ship. A small, tethered powered air vehicle could be an alternative solution to an aerostat, although its air time would be relatively more limited and the power source, depending on its location, would add additional weight to the vehicle or tether system, possibly beyond the equipment needed to provide power to operate the radio.

The USV will be launched and recovered from the LCS, and the aerostat will be semi-autonomously deployed and elevated from, tethered to, and, ideally, recovered by the USV. Once the USV is launched from the LCS, an operator aboard the LCS will control the USV remotely through the MVCS and will remotely command deployment and retrieval of the aerostat. Given the technical challenges involved, retrieval and stowage of the aerostat itself may be more difficult, slow, and energy consuming than desirable. A goal is to retrieve the radio itself. Jettisoning of the aerostat and any associated equipment should not pose danger to marine life or pose an environmental hazard. An aerostat to be jettisoned should be of low enough cost to make that option acceptable in comparison to the cost of retrieval. A retrieved or jettisoned aerostat should not interfere with the operation of or threaten damage to the USV.

The aerostat must be launched while carrying the radio and handing the weight of the tether. While an operator on an LCS platform will provide commands to the USV through the MVCS, the actual mechanical operations must be done unmanned. Power must be provided to the radio. The aerostat communications relay system, including all components, must be designed for minimal weight and storage. Weight, including payloads, is important because of its effect on fuel use and, therefore, mission length. Similarly, fuel consumption must be considered in development of the operation of the lifting and retrieval mechanisms and the process for maintaining aerostat altitude. Since the final UISS USV design has not been settled on, the whole system should be modular and adaptable. Such flexibility will enhance its potential for use on other USVs. The Phase I feasibility study and Phase II prototype development and demonstration may be done from a craft similar in size to the planned UISS USV. The demonstration craft may be manned so long as the aerostat operation is demonstrated autonomously. Integration into the UISS USV and operation though the MVCS would occur in Phase III.

The USV and aerostat communications relay shall stay operational for four days or longer without any planned maintenance such as refueling the USV or, for instance, adding helium to the aerostat if that gas were part of the solution. The communications relay shall operate and maintain communications between the LCS and unmanned systems in Sea State 3 or greater. The relay shall operate at an altitude of 500 feet or higher with the RT-1944/U radio system installed.

PHASE I: The company will develop concepts for an aerostat communications relay system meeting the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. The company will demonstrate the feasibility of the concept by specifying material components to be considered and modeling and simulation of the high risk procedures. The company will provide a Phase II development plan with performance goals and key technical milestones that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will produce a prototype aerostat communications relay system. The company will test and evaluate the prototype system on a craft similar in size and capacity to the planned UISS USV to determine its capability to meet the performance goals defined in Phase II development plan and the Navy requirements for an OTH aerostat communications relay system. The company shall demonstrate the prototype system to the government and evaluate the results. The company will use the evaluation results to refine the prototype into a pre-production design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for use in the MCM MP UISS USV. The company will need to work with the supplier of the UISS USV to integrate the system onto the USV. The company will support test, validation, certification, and qualification of the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Long-range communications from USVs to bases has applications to homeland security, oceanographic research, and, potentially, protection of commercial shipping.

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8. RSS RT-1944/U Installation Control Document. (Uploaded in SITIS 12/10/12.)

9. LCS-1 Stern Door Dimensions, uploaded in SITIS 12/19/12.

10. LCS-2 Stern Door Dimensions, uploaded in SITIS 12/19/12.

KEYWORDS: Over the Horizon communications relay; autonomous aerostat launch and retrieval; Unmanned Influence Sweep System (UISS); Littoral Combat Ships; Multiple Vehicle Communications System (MVCS); Unmanned Surface Vehicle (USV)

N131-040 TITLE: Affordable Point of Use Conversion (PUC) Module for 400Hz Power System Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS320, Electric Ships Office

OBJECTIVE: Develop an affordable and compact Point of Use Conversion (PUC) module for 60 Hz to 400 Hz and 270 VDC power converters for shipboard applications.

DESCRIPTION: Currently 400 Hz power systems onboard US Naval amphibious ships and destroyers use centralized and redundant frequency conversion, whereby 400 Hz power (defined by MIL-STD-1399) is generated in centralized locations and is then distributed to numerous loads located throughout the ship. This distribution system approach leads to the placement of large and expensive frequency converters at strategic locations onboard the ship and long cable runs. Additionally, the needed distribution equipment feeding all the 400 Hz loads is redundant to the 60 Hz distribution system. A more effective and survivable approach would utilize the existing 60 Hz distribution system to provide power to compact PUCs located directly at the load site. This would eliminate the need for separate 400 Hz distribution systems and eliminate the need for all the 400 Hz distribution equipment such as transformers, bus transfer switches, cableways, collars, and multiple cable transits penetrations. Since many 400 Hz vital loads are sensitive to power interruptions, most of these loads are fed via manual bus transfers, which require manual switching if the primary source of power is lost.

The state of the art in power conversion equipment components has progressed suitably to allow for the development of compact PUCs that would fit in available spaces near to the loads and provide the power quality the loads require. However, the integration of those components in a small package while meeting tight electrical system tolerances that define Type II and Type III power will be a significant technical challenge to overcome. Type II power is 440 VAC or 115 VAC, 400 Hz ungrounded and Type III is similar, but with a tighter tolerance, as defined by MIL-STD-1399. The power density of commercial power electronics has increased due to the development of higher power ratings for the Silicon based components to fit within the tight ship constraints. But, the harsh nature of a naval environment will be a challenge due to limited cooling as well as high shock and vibration loads will require novel approaches to packaging the devices in a module. More advanced components based technology such as Silicon-Carbide may be necessitated to reduce the overall thermal load and advanced cooling techniques such as (but not limited to) direct spray cooling of the electronics to reduce the overall size. While the state of the art indicates this could be achievable, actual integration of the new or developmental components in to a working PUC module is a high risk. New power electronics technologies hold the potential to offer benefits which will result in simplified electrical distribution architecture and increase flexibility, survivability, reliability and efficiency for Navy systems (reference 3).

The Navy seeks to develop PUC module technology for local power conversion from 60 Hz to 400 Hz for both Type II and Type III 400 Hz and 270 VDC power to reduce total ownership costs (reduced acquisition, integration, and maintenance costs associated with a separate 400 Hz distribution system) and improve reliability and performance by virtue of a simplified electrical distribution system architecture. Proposed PUC technology would need to be applicable for the loads that require 440 VAC be converted to 270 VDC by eliminating the need for power converters dedicated to that special use voltage for aircraft service loads.

The need is to develop a PUC whose size, weight, and cost would enable placement in proximity to the load site with minimal ship integration impact (able to pass through a 26”x66" oval opening and mountable on a ship’s bulkhead for arrangement flexibility). Proposed PUC module concepts should provide high quality output power (with the 440 VAC input) that exceeds the requirements of MIL-STD-1399-300 for 440 VAC and 115 VAC at 400 Hz and be able to provide 270 VDC and shall meet the definition of power conversion modules contained within reference 1. Power densities for the proposed solution shall have a threshold of 2 MW/m^2 with an objective of 3 MW/m^2. Proposed concepts will need to be address load survivability during system electrical faults and power interruptions by limiting current and being capable of seamless switching to alternate 60 Hz supply power sources. PUC modules should be able to isolate faults at the load site, without affecting adjacent loads or the rest of the electrical distribution system. Furthermore, these modules must protect the load from upstream anomalies such as high harmonics and input voltage swings exceeding ±10%. The goal is to preserve power to the loads such that when the loads have two sources of power, the loss of one source will not cause a power interruption to the load.

Proposed PUC module concepts should meet the applicable performance goals for 60 Hz to 400 Hz frequency converters in MIL-PRF-32272, Performance Specification, Integrated Power Node Center (IPNC) and shall conform to reference 2.

PHASE I: The company will develop concepts to determine the feasibility of the development of a PUC module for use in shipboard power system applications with capabilities outlined in the description above. As applicable, the company will demonstrate the effectiveness of the solution with modeling and simulation. The company will develop an initial conceptual design and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete product development milestones for verifying performance and suitability for Navy needs. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of the Phase I and Phase II plan, the company will develop and demonstrate the prototype(s) as identified in Phase I. Through system simulations, demonstrate and validate the performance goals as established in Phase I. The prototype must meet applicable performance goals of MIL-PRF-32272. The small business will further refine the prototype into a converter compatible with packaging requirements and military standards listed above and the company will refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy and applicable Industry partners in testing, validation and transitioning the technology for Navy use. The company will develop the converter systems for evaluation to determine its effectiveness in an operationally relevant environment. The final system is expected to be modular to accommodate various shipboard power distribution system architectures. The small business will participate in an integrated product team environment to develop the detailed interfaces required to integrate the converter with the power system and the combat systems loads.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advances in point of use conversion modules for naval applications will provide enhanced capability directly applicable to commercial applications, resulting in improved performance, higher reliability, increased durability, and graceful degradation. For example, terrestrial power systems such as micro-grids would benefit from compact and affordable power conversion local to the end use application. This technology would also be applicable to commercial shipping, future electric cars and renewable energy markets.

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2. "Naval Ships' Technical Manual Chapter 320 Electric Power Distribution Systems." S9086-KY-STM-010/CH-320R2 21 APR 1998. Date of access 18 March 2012 <http://www.fas.org/man/dod-101/sys/ship/nstm/ch320.pdf>

3. CAPT Petersen, Lynn, Hoffman, Donald, Borraccini, Joseph, & Swindler, Steven. "Next-Generation Power and Energy: Maybe Not So Next Generation." Paper from ASNE Engineering the Total Ship 2010 Conference, July 2010. Date of access 22 March 2012 <https://www.navalengineers.org/SiteCollectionDocuments/2010%20Proceedings%20Documents/ETS%202010%20Proceedings/Petersen_Paper.pdf>

KEYWORDS: point of use power conversion; power frequency conversion; power electronics; power distribution; simplified electrical distribution; 400Hz power systems

N131-041 TITLE: Semi-Autonomous, Reliable, Safe Recovery of the Remote Multi-Mission Vehicle (RMMV) in Various Sea States.

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS403, Remote Minehunting System Program Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop technology for an autonomous, reliable, and safe system for Littoral Combat Ship INDEPENDENCE Variant to recover the RMMV in various sea states.

DESCRIPTION: The Remote Multi-Mission Vehicle (RMMV), a Snorkeler Class Unmanned Surface Vehicle (USV) per reference 1, is a semi-autonomous, semi-submersible vehicle launched and recovered from the Littoral Combat Ship (LCS). As stated in reference 2, the RMMV is seven meters in length with a diameter of 1.1 meters and has four degrees of freedom (roll, pitch, yaw, heave). The effect of roll particularly has been evident during RMMV recovery testing on the LCS INDEPENDENCE Variant. The RMMV recovery operations have not been consistently well-timed or reliably repeatable by the coordinated effort of the final two operators controlling the RMMV and the mechanism to capture the RMMV, especially under varying sea state conditions. Slow human response times, leading to misalignment of the RMMV to the capture mechanism, could result in damage to the vehicle, capture mechanism, and other recovery equipment. The facilitation of autonomous recovery can save time, fuel, and manpower aboard their host platforms, all of which lead to cost savings in addition to risk mitigation.

The current process to recover an operational tactical RMMV consists of multiple steps and the final coordination of two operators in the ship's mission bay. One operates the Remote Operator Pack (ROP), a portable control interface in the mission bay. The other operates the Twin Boom Expandable Crane (TBEC). Prior to their involvement, a human operator in the ship's Mission Control Room (MCR) assumes control of the RMMV and directs it to return to the ship using a combination of over the horizon (OTH) and line of sight (LOS) communications. As the RMMV approaches, the MCR operator confirms visual acquisition of the target when it is approximately 1000 yards aft of the ship. The MCR operator then transfers control of the RMMV to the ROP operator. Both the ROP operator and the TBEC operator maintain a visual lock on the RMMV. The ROP operator closes the distance between the RMMV and the ship. While this is occurring, a tow line loop is released from the mission bay stern door, such that it floats on the surface, by line handlers stationed at the mission bay stern doors. While observing the mast of the RMMV approaching the tow line, the ROP operator commands the RMMV to surface and the tow line loop is reeled in until it is caught by the tow hook on the RMMV. This line provides a constant restraint during recovery. When the tow line is hooked, the ROP operator puts the vehicle propulsion into neutral and the tow cable is reeled into the ship, closing the gap between the RMMV and the ship. During this time, the ROP operator provides commands to the RMMV control surface assemblies to keep the RMMV stable as it traverses the turbulent wake of the LCS During the recovery process, the aft doors of the LCS mission bay are open and the TBEC operator extends the Crane from the stern of the LCS, with the Capture Spine Assembly (CSA) attached. When the RMMV is stable and under the CSA, the TBEC operator lowers the CSA to mate to a spine on the RMMV and raise the vehicle from the water.

What is desired is automation of key operations of the ROP and TBEC portions of the recovery process to provide quicker response times than the human operators can achieve while trying to compensate continually for changing turbulent wake field conditions. The goal for the ROP portion is for the RMMV to pose in a steady state position beneath the CSA, primarily by limiting RMMV roll while under tow from the LCS. Automation in the TBEC operation would lower the CSA in a controlled and safe manner to reliably capture the RMMV within the optimal range of relative motion of the mechanism and the vehicle. General autonomy references are provided by References 3 and 4. A significant amount of research has been conducted on automating launch and recovery of remotely operated vehicles (ROVs) and unmanned vehicles; however, no practical solutions have been generally accepted by industry or government organizations. Recovery operations continue to be manpower intensive. Reference 5 provides additional information important to understanding the problem and to developing potential solutions

PHASE I: The company will develop concepts for the semi-autonomous recovery of RMMV in various sea states in light of the design constraints identified above. The company will investigate an innovative solution in meeting Navy needs and will establish that the solution can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling and simulation. The company shall document the proposed method of autonomous recovery. The company shall describe the approach it envisions for installing the proposed hardware and software on the LCS Independence variant and the RMMV. The company shall describe the essential characteristics of the recovery controller supported by feasibility simulations of recovery. The small business will provide a Phase II development plan with performance goals and key technical milestones that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation as appropriate. The key software and hardware components of the prototype will be initially tested in a lab and pier side and evaluated by the company to determine their capability to meet the performance goals defined in the Phase II development plan and the Navy requirements for the Semi-autonomous recovery of RMMV in various Sea States. The company will then construct a prototype system and support Navy demonstration and evaluation of the system performance through prototype testing and evaluation on an Independence-class LCS (or equivalent alternative) and an RMMV over the required range of parameters including numerous deployment cycles. The company will use the evaluation results to refine the prototype into a design for a first-order production unit that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will produce a sensor suite, controller, and integration plan for the semi-autonomous recovery of RMMV in various Sea States. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A lucrative market current exists for at-sea recovery of Autonomous Unmanned Vehicles (AUVs). Current commercial recovery procedures involve stopping both host platform and AUV and hooking lines between the two vehicles. Institutions such as Woods Hole Oceanographic Institute and private industries supporting the petroleum industry all use AUVs and conduct numerous launch and recovery operations every year. The minimal installation of hardware on an AUV is seen as an advantage since most of the installation and integration of equipment can take place on the host platform performing the recovery, providing a stable, dry, installation friendly base.

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4. Intelligent Vehicle Systems: A 4D/RCS Approach (Editors: R. Madhavan, E. Messina, and J. Albus), Nova Science Publishers, Inc., Dec 2006.

5. "Additional Guidance for Semi-Autonomous, Reliable, Safe Recovery of the Remote Multi-Mission Vehicle (RMMV) in Various Sea States," posted in SITIS 11/27/12.

KEYWORDS: semi-autonomous recovery; unmanned maritime vehicles; Remote Multimission Minehunting Vehicle (RMMV); Littoral Combat Ship (LCS); wake field; reliable and safe recovery operations

N131-042 TITLE: Multi-Function Mid-wave/Long Wave Infrared Laser

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

OBJECTIVE: Develop a dual band mid-wave (MW) and long wave (LW) infrared (IR) laser with 10-20 Watts output power and two pulse repetition frequency (PRF) modes of operation.

DESCRIPTION: A multi-band, multifunction IR laser is required to counter non-imaging and imaging IR guided anti-ship missiles (ASM) as demonstrated in numerous field tests (ref 1). The current pulsed laser technology (ref. 2-3) offers separate laser systems optimized for each wavelength band (ref. 2-3) and a single PRF or a narrow range of PRFs. This means the Navy would need multiple lasers to counter the threat in a large, complex, and costly system that will complicate installation and affordability issues for shipboard applications, thus improving performance and capability. While high power pump lasers and emerging nonlinear optical materials are available as described in references 2-3, an innovative laser design that will enable laser operation in two PRF modes sequentially with mode switching time under 1 second is required to overcome the aforementioned limitations of current laser technologies and reduce the number of (up to) four IR lasers to a single source. Major technical challenges in this new laser design include efficient laser operation in two distinctly different PRFs, maintaining efficient wavelength conversions in the higher PRF mode and avoiding crystal damage in the lower PRF mode.

Innovative laser architecture is needed to meet the multi-band, high power, and multi-PRF requirements. Wavelength flexibility within both MW (3.5-5 micron) and LW (7.5-9.5 micron) bands is required. A minimum of two different wavelengths with high atmospheric transmission in each of the IR bands (MW and LW) is required with more flexible wavelength tuning within the MW and LW bands being highly desired. The two PRFs required for sequential operation are 10-20 kHz and >500 kHz. Robust, high reliability operation with minimal maintenance is required. Highly monolithic waveguide based solutions are desired although hybrid and alternative approaches will be considered. The technology developed under this topic will eventually support development of a ruggedized field unit and potentially an operationally deployed system.

It should be noted that the two PRF modes are not required to operate simultaneously but switching between modes must be selectable in the field by user command with less than 1 second switching time. Also, simultaneous operation in the two separate bands is not required but again switching between modes must be selectable in the field by user command with less than 1 second switching time.

The Navy is seeking to develop and evaluate laser system technology that can be scaled to meet the requirements for a field unit. A key part of the program will be the brassboard unit in which feasibility can be established for a prototype unit to be tested in the field.

The key to brassboard effort is to demonstrate multi-mode and multiple band operation at power levels that can be scaled to field unit goals of 10 – 20 watts. The brassboard does not need to implement commandable electronic switching between operation modes nor wavelength bands. However, the effort must include the design for a robust switching mechanism. Detailed analysis, and laboratory evaluation needs to be developed to demonstrate a clear path to achieve the field unit requirements. The scalable areas to be addressed are wavelength conversion pump source power scaling, wavelength conversion material power handling capability, and approach to handle the wide pulse repetition factor.

PHASE I: The company will develop concepts for a multi-function MW/LW IR laser that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the multi-function MW/LW IR laser. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Multi-Function Dual IR Band Laser prototype for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Both the military and commercial sectors can use advanced high power multi-function, multi-band laser sources for remote sensing of toxic chemical species for troop and civilian protection applications. This will have applications in base protection as well as homeland security, and urban police activities. Additionally, it is anticipated the multi-mode operation will be of use in remote earth science applications for crop, soil, and geo-resource sciences and monitoring for NASA and commercial entities. Finally, the high power variable modulation format sources can be used in scientific applications for determination of high-resolution spectroscopic dynamic processes in chemical reactions for medical and chemical processing activities.

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1. Lum, Z, “Summer Sees Shipboard EW Stirrings.” Journal of Electronic Defense, Sep 1995.

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KEYWORDS: Flexible wavelength tuning laser; multi-function laser; multi-band laser; mid wave IR; long-wave IR; multi-pulse repetition frequency

N131-043 TITLE: Autonomous Classification of Acoustic Signals

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS485, Maritime Surveillance Systems, Distributed Sensors Group.

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop signal processing computational techniques and methods for autonomous (no man-in-the-loop) classification of passive acoustic signals from fixed, wide-aperture planar arrays.

DESCRIPTION: The Navy needs an innovative approach to autonomous classification of passively detected acoustic data. Specifically, new distributed 2-D planar arrays and potentially, autonomous platforms have tremendous potential for persistent monitoring of surface and subsurface acoustic targets. The Navy already has the capability of collecting large volumes of passive acoustic data; however, the data is analyzed weeks after collection. Today, tactical and strategic forces need immediate processing and classification of passive acoustic data. To meet this need, existing and future distributed systems must be able to acquire, process, detect and autonomously classify surface from subsurface acoustic contact data to support contact messaging to others, at a high confidence level.

A wide variety of software tools are available for collecting and analyzing marine acoustic data; but, most existing tools require a trained operator to detect, classify, and track surface and subsurface contacts. Prior year efforts, referenced in Refs (1-4,) evidenced potential for processing and autonomous detection from planar arrays, but the state of computational capability and software design resulted in unacceptable detection reliability. The Navy believes a giant leap-forward is possible and potentially supported by the small business innovation base.

Some attractive concepts have focused on physics-based source localization, relying upon the integration of acoustic wave propagation modeling with the spatial filter or beam-former (see Ref. 1) to provide an estimate of source range and depth. Such model-based processing must overcome incomplete knowledge of the physical ocean waveguide, which is required to model the signal (see Ref. 2). A number of approaches have been proposed to meet this challenge, including adaptive methods (see Refs. 3 and 4), and methods that exploit robust properties of the waveguide itself (Ref. 5). New approaches would process fixed wide-aperture planar acoustic array data and autonomously detect, localize, classify, and track, contacts.

Navy has been unable to identify traditional sources for integrated approaches that function in the acoustic-only domain. This topic seeks an integrated approach that is better aligned with the passive acoustic processing challenge and specifically addresses three key capabilities: (1) autonomous and robust classification of received acoustic signals differentiating surface contacts from subsurface contacts, (2) suppression of loud fast moving surface-ship acoustic interference in realistic ocean environments, and (3) automated in-situ techniques estimating environmental parameters needed for accurate modeling of the contact and interference signals (as needed in items 1 and 2). Although all proposed methods will be evaluated on their merits, note that contact depth is an undeniable classification feature.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as classified data will be provided to support Phase I work. The Phase II effort will use more robust data sets; Phase III will migrate to classified data.

PHASE I: The company will develop innovative concepts for any or all of the three key technical capabilities described in the description, capable of being integrated into a persistent real-time acoustic autonomous processing system. The company will demonstrate the feasibility of its concepts using unclassified data (either modeled or from realistic ocean environments) in a suitable simulation or analysis of its proposed approach. The small business will provide a Phase II development plan for concepts developed in Phase for two distinct applications: (a) ashore/afloat where size and power constraints are relaxed, and (b) a Distributed/Netted System concept of autonomous undersea surveillance systems where size, low power and endurance requirements are a premium. It will address performance goals, key technical milestones and technical risk reduction.

PHASE II: Based on the results of Phase I and using the Phase II development plan, the small business will develop a scaled prototype real-time autonomous signal processing architecture implementing the Phase 1 software concept hosting the innovative software on commercial-off-the-shelf hardware The company will demonstrate performance in the lab and compare it with metrics established in the Phase I effort and against synthetic datasets representative of operational applications. Computational complexity will also be addressed in Phase II. This effort may require access to classified information. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The contractor will be provided classified data as required. Specifically the prototype developed in Phase II will be integrated with a suitable surveillance sonar system and used in a proof-of-concept test to determine overall systems effectiveness including detection and classification performance, reliability, and persistence. In parallel, the company will continue to refine its design for evaluation to determine its effectiveness in operationally relevant environment(s). The company will support the Navy for test and validation to certify and qualify the system for Navy use and will support the transition of the developed technology to appropriate Navy systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The automatic classification technology will be useful in Department of Homeland Security (DHS) port protection, Drug Enforcement Agency (DEA) drug interdiction and finding fish and mammals in the commercial and university research sectors.

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KEYWORDS: passive acoustic data; autonomously classify; autonomous contact detection; automated contact reports; adaptive methods; automated in-situ techniques

N131-044 TITLE: Mission Planning Application for Submarine Operations and Risk Management

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMS 425, Submarine Combat and Weapons Control (AN/BYG-1); Capable Manpower

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OBJECTIVE: Develop mission planning decision aids (including displays) that integrate disparate submarine system data and make risk based recommendations on courses of action for the Commanding Officer.

DESCRIPTION: Submarines conduct operational missions in a complex environment based on tasking from operational commanders. While many missions are similar, each mission is unique in that environmental changes, political factors, crew capabilities, allied forces, adversarial forces, and commercial activities vary with each mission. At its heart, mission planning is a sequence of decisions and tasks that appropriately balance risk against gain. Understanding operational risk is critical, and managing risk is necessary to affect predictable outcomes.

Submarine crews are operationally tasked with text messages and then they develop operational plans using a group of tools that do not integrate needed inputs. Plans today must be memorized from content kept in binders, or integrated mentally from a variety of displays and media. These currently include many manual processes, PowerPoint charts, overlay functions in the Combat Control System, charting in the Voyage Management System, operational structure in guidance from the operational commander, and ship and crew status such as equipment conditions and watch qualifications and experience. (See Ref. 1.)

The Navy seeks a suite of task-centered, intuitive and easy to operate mission planning software tools to assist the submarine Command Team in planning and assessing alternatives for an operational timeline that span time periods from weeks in the past, to weeks into the future. Such a tool would allow alternative voyage tracks, changes in the ships posture and the conduct of specific activities in the execution of operational objectives. The output of the planning function will support briefing the team on duty in the control room as well as the submarine Command Team in a space other than the control room. The planning tool will support a "Plan-Brief-Execute-Assess" methodology that is used by submarine operators to prepare operational and combat missions at sea. The tool will also be developed to support a format that can be shared and displayed off the submarine. The Mission Assessment function should be designed so the Commanding Officer, Command Duty Officer and Officer of the Deck can monitor a plan’s real-time execution and highlight deviations that may require command attention. (See Refs. 2, 3, 4.)

There are currently several incarnations of software tools in the areas of maritime voyage planning, ground war campaign planning, statistical decision-making, map-based products, and advanced database techniques, which all factor into the planning tool that is envisioned. There are a great number of applications and user considerations that must integrated into the design of the tool. Of critical importance to this project, however, is the research leading to the development and effectiveness of specific, relevant and well-designed human system interfaces (HSI) that will seamlessly support the complexity of submarine operations. (See Ref. 5.) A user-centered spiral approach that includes regularly scheduled usability testing will be employed in the development of the mission planning tool. Impacts to the associated costs of training, maintenance and reliability will also be considered.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for an improved Mission Planning System that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by evaluation against the stated requirements. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Mission Planning System. System performance will be demonstrated through prototype evaluation in the Command and Control Center (CACC) Alternatives Study and Experimentation (CASEX) lab in Newport, RI. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Mission Planning System for evaluation to determine its effectiveness in BYG-1 Submarine Combat Control System, submarine operational staffs and training centers. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications for mission planning applications range from complex logistics companies, disaster response by federal, state, and local government agencies, utility companies, and farming. Health-care in particular is a potentially fruitful area where surgical and diagnostic processes could be normalized, shared, optimized, and made transparent. The ability to monitor performance by comparing executed missions to planned missions would support the trend toward accountable care and accountable organizations.

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15 pages, 12/12/2012. (Uploaded in SITIS 12/19/12.)

KEYWORDS: operational task analysis; Human Systems Integration; cognitive workload; data fusion; rule-based decision support systems; risk management.

N131-045 TITLE: Mitigation of Biologically Induced Active Sonar Reverberation in Littoral Regions

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 5A, Advanced Systems and Technology Office.

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop technology to improve performance of active sonar by reducing the effect of biological backscattering in littoral regions.

DESCRIPTION: Sonar performance is degraded in littoral waters because of the abundance of marine life.
Resonant backscattering from marine life (fish air bladders, for example) reduces signal to noise ratio by increasing the background level and by mimicking targets. Current sonar systems lack the ability to discriminate between targets and clutter caused by marine life, reducing the ability to perform detection, classification and localization of targets (references 1-5).

Past efforts to improve active sonar performance in the littorals with existing state of the art systems, such as the AN/SQS-53C, have included waveform development and data fusion techniques. Current research has targeted using characterization of fish bladder resonance in classification techniques (references 6-8). Targeting reduction of reverberation prior to classification based on an understanding of the effect of biologics is a largely unexplored area of investigation.

The Navy is seeking concepts, processing, or techniques beyond state of the art, which will ameliorate the resonant backscattering due to biologics. Extant research on the characteristics of biologically induced backscattering exists that can be exploited to develop technology that reduces the backscattering effects of marine life in existing active sonar systems. Innovation is sought to develop methods that incorporate the resonant characteristics of marine life to reduce their backscattering effects on active sonar. These innovative methods may include, but are not limited to, signal processing algorithms, transmission/operational characteristics, and system hardware. Methods should address not only capability, but also cost effectiveness. The resulting technology should provide a significant improvement in the performance and detection capability of active sonar by reducing the number of false contacts and improve operator work load by decreasing the amount of display clutter. The technology will be integrated into sonar system processing to improve performance and detection capability.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts to ameliorate acoustic resonant biological backscattering that meets the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a concept, process, or technique prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the active sonar. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop improved active sonar for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial active sonars that experience biologically induced backscattering may incorporate this technology, for example, it could be used for bottom and sub bottom profiling. One industry would include mapping for cable laying.

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2. Chapman, R.P. "Deep scattering spectra in Atlantic and Pacific", Journal of the Acoustical Society of America, Volume 56, Issue 6 December 1974: pp. 1667-1672.

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6. Stanton, Chu, Jech. "Acoustic Resonance Classification of Swimbladder-Bearing Fish", Office of Naval Research. 2010, Office of Naval Research. 3 May 2012 <http://www.onr.navy.mil/reports/FY10/npstant.pdf>

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8. Gauss, Love. "Moment-Based Physical Models of Broadband Clutter due to Aggregations of Fish", Office of Naval Research. 2011, Office of Naval Research. 3 May 2012 <http://www.onr.navy.mil/reports/FY11/oagauss.pdf>

KEYWORDS: Biological Backscattering; Active Sonar Reverberation; fish air bladders; reduction of reverberation; detection classification localization; biologics in littoral regions

N131-046 TITLE: Maritime Dynamic Atmospheric Characterization for Naval Laser Weapons System

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: Solid State Laser Technical Maturation Program

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop an innovative atmospheric attenuation measurement system capable of 24/7 operation and suitable for integration on a shipboard platform to determine expected atmospheric attenuation prior to a high power laser engagement.

DESCRIPTION: The potential for deployment of Laser Weapons Systems aboard Naval Vessels necessitates the ability to dynamically characterize the maritime atmosphere to predict laser effectiveness. The Navy is seeking novel approaches to allow a ship to determine atmospheric attenuation on a continuous or discrete basis, and use this information to generate a 'Laser Effectiveness Range' for use by the ships tactical team to determine whether the laser system is an appropriate weapon choice for a given threat. Atmospheric characterization in both azimuth and elevation is desired to allow for improved weapons selection ability against surface and airborne targets. Systems (ref 1) designed to operate with reduced or minimal maintenance requirements and/or operate as a stand-alone device will be more strongly considered. Offerors should concentrate their efforts on the 1.0-1.1 micron optical transmission window of the atmosphere, the anticipated bandwidth for shipboard naval laser weapons.

Having a method to measure the anticipated attenuation along the propagation path prior to a high power laser engagement is necessary to determine weapon effectiveness. Two different mechanisms contribute to the attenuation that a laser will experience while propagating through the atmosphere - absorption and scattering. In a maritime environment, scattering from water droplets is a primary contributor to overall attenuation, especially for horizontal paths along the ocean surface. Molecular absorption has been well characterized and modeling codes exist to allow for accurate predictions of transmission as a function of wavelength. A system to measure total attenuation must take both factors into account.

Both passive and active techniques exist for measuring atmospheric attenuation. Active systems such as transmissometers (ref 2) and nephelometers sample a known atmospheric path at a specific wavelength and have separate transmit and receive modules. Transceiver type systems are similar to transmissometers except that the transmitter and receiver are co-located and they utilize a cooperative target such as a corner cube reflector to measure the round trip extinction. Light Detection and Ranging systems utilize a laser source to analyze the aerosol backscatter along the laser path and can determine aerosol attenuation based on these measurements. Active systems have the advantage that they can be designed to operate at the same wavelength as the high power laser source. However, some of these systems are designed to sample the atmosphere over a very short distance which may not take into account changing atmospheric conditions away from the ship. In addition, the use of a laser or other light source can act as a beacon to enemy threats, revealing the ships position and/or status.

Passive systems are attractive because they do not require a laser “beacon” to make the measurement. These systems analyze the contrast between a dark target or object at a known range and the horizon. It may be possible to utilize existing shipboard sensor systems to function as a contrast imager. However, these systems can be susceptible to particular environmental conditions that can affect the contrast measurement but not the actual extinction along the path. In addition, they may have difficulty working at night.

The goal of this topic is to conceive and determine the feasibility of a novel atmospheric attenuation measurement system capable of 24/7 operation in a maritime, shipboard environment. Ideally, the system will collect information at the laser wavelength between 1.0 and 1.1 microns and should be capable of measuring attenuation along horizontal paths near the ocean surface as well as non-horizontal slant paths.

PHASE I: The company will develop concepts for an atmospheric attenuation measurement system that satisfies the requirements described above. Active or passive approaches are acceptable but approaches that require no additional shipboard logistics are preferred. The company will demonstrate the feasibility of the concepts in meeting Navy Needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will also provide a Phase II development plan with key performance parameters for the system, key technical milestones to be achieved and a risk assessment with mitigation strategies to reduce high and moderate risk aspects of the plan.

PHASE II: Based on the results of the Phase I and Phase II development plan, Phase II will focus on the fabrication of a prototype system for test and evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals and milestones defined in a Phase II development plan. Testing will be conducted in both a laboratory setting to establish system baseline performance and at a suitable outdoor test facility, preferably one that has an over water test range that allows for measurements over propagation distances exceeding one kilometer. Evaluation of early test data will be used to refine the prototype into an initial design that will be robust and durable for use in a shipboard environment. A functional prototype of the initial working device including software required to fully operate the prototype will be made available to a naval surface warfare center for subsequent verification of test results and for assessment of the device's capability to operate in a maritime environment without significant degradation. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will transition the prototype design to a robust and durable system capable of operation in a maritime environment. The system will be tested to ensure it meets military standards for temperature, shock, vibration and other requirements. At sea, field testing will be conducted to ensure proper performance in a relevant environment. The company will support the Navy for test and validation to certify and qualify the system for production and Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector use of this technology could be in the areas of enhanced visibility measurements for transportation applications such as airports, highways, and shipping ports. It also has applications for free space atmospheric communication links.

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2. Malm, William C., "Considerations in the accuracy of a long-path transmissometer," Aerosol Science and Technology, 14: 459-471, 1991.

KEYWORDS: Laser propagation; atmospheric attenuation; absorption; scattering; long-path transmissometer; nephelometers

N131-047 TITLE: Improved Detection, Localization, and Classification of Torpedoes

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO-IWS-5A Advanced Systems and Technology Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to improve acoustic detection, classification, or localization (DCL) and reduce false alarms for multiple classes of torpedoes using hull array acoustic sensors.

DESCRIPTION: The detection, classification and localization of torpedoes are of the highest importance to surface combatants. The Navy is seeking improvements in capability and performance to current torpedo defense systems;

especially technologies that help improve detection and reduce false alarm rates resulting in a more reliable system for the fleet when only hull-array data is available. The current design automated detection, classification, and localization algorithms for torpedoes are class-specific and will not provide adequate probability of detection / false alarm rate performance against the full scope of enemy weapons (current and future.) Innovation is sought to further improve Navy capability to use the hull-mounted sonar to detect incoming torpedoes. The current Navy torpedo recognition system on surface combatants relies on automated torpedo detection, classification, and localization, (TDCL) algorithms using acoustic sensor data from hull and towed arrays. There are many scenarios in which the towed receiver is not available. During these periods the burden for TDCL is shifted to the hull array, which is uniquely capable of providing forward-sector coverage. This forward sector is critically important given threat tactics, as well as Anti-Submarine Warfare (ASW) prosecution tactics. Technological risks associated with this effort are overcoming higher noise levels associated with hull mounted sensors, and mitigation of interfering active acoustic transmissions. References 1-3 provide a brief description of AN/SQQ-89 sensors and combat systems. References 4-6 provide examples of detection, classification, and localization tracking and classification algorithms.

The Navy seeks technologies for improved automated DCL of torpedoes or salvos (multiple, simultaneous launches) of torpedoes using the existing sensor suite, with emphasis on use of the hull array acoustic sensor. The desired result is improved detection performance against all classes of torpedoes with low false alarms. New approaches should exploit the full bandwidth of the hull array sensor, whether passive or active, and could include multi-sensor mutual information from other available sensor data [Ref 1]. In addition, innovative algorithms that reliably identify and localize salvos, groups of incoming torpedoes, are of interest. Automated discrimination of torpedoes from other acoustic sources is of critical importance. False alarms reduce the effectiveness on any system. Classification of torpedoes by type (or class) is not a requirement, but class-specific algorithms could improve false-alarm performance. Important performance metrics for torpedo defense algorithms include probability of detection, detection latency, false-alarm rate, and localization accuracy.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The Company will develop concepts for Improved Detection, Localization, and Classification of Torpedoes that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established through analytical modeling, and developing and documenting the innovative algorithms and quantifying torpedo detection and localization performance with simulated or recorded sea data. The small business will provide a Phase II development plan with performance goals and key technical milestones that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype algorithm for evaluation as appropriate. The prototype algorithm will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for Improved Detection, Localization, and Classification of Torpedoes. System performance will be demonstrated through prototype algorithm evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles and testing with a large number of data sets, including test cases not used for development. The company will quantify detection and false alarm rate performance. Evaluation results will be used to refine the prototype and generate a design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will participate and assist the Navy in testing of the algorithms developed in Phase II in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the algorithms for Navy use. The company will integrate the software into the surface ship ASW combat system Advanced Capability Build (ACB) program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Automated detection and classification algorithms have a wide range of potential for commercial surveillance and security systems. These systems use a mix of acoustic, video, radio-frequency, and infra-red sensors to detect, localize, and identify artifacts of interest.

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1. “DDG-51 ARLEIGH BURKE-class”. Federation of American Scientist. 12 April 2012. <http://www.fas.org/programs/ssp/man/uswpns/navy/surfacewarfare/ddg51_arleighburke.html>

2. “Arleigh Burke Class Destroyer”. Wikipedia. 11 April 2012. Wikipedia Foundation Inc. 12 April 2012. <http://en.wikipedia.org/wiki/Arleigh_Burke_class_destroyer>

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KEYWORDS: Torpedo Defense; Torpedo Detection; Torpedo Classification; Torpedo Localization; Torpedo Recognition; Hull Arrays

N131-048 TITLE: Technologies to Aid Real-Time Training, Evaluation of Student Performance, and Capture of Performance Metrics

TECHNOLOGY AREAS: Electronics, Human Systems

ACQUISITION PROGRAM: PMS 339, Surface Training Systems Program Office

OBJECTIVE: To develop innovative techniques for the real-time capture of student performance metrics to aid instructors in training and performance assessments.

DESCRIPTION: Sailors are trained on a wide variety of complex tasks through the use of simulators. For well over two decades, simulation has proved to be a highly cost effective method for developing important skills and for building proficiency. However, the full promise of simulation as a training method is sub-optimized. In even the most advanced simulators, an instructor must still be present with the student in order to provide mentoring as well as to assess performance and provide feedback; all of which relies solely on the instructor's visual observation of the student and still requires the instructor to manually record, track, and database those observations. This way of training is costly, and despite significant advances in simulation to facilitate and improve training, student throughput is constrained by the number of available instructors to support the critical assessment dimension of training. The demand for training complex tasks in simulated systems has been growing over the past decade and is exceeding the current amount of available instructors, but the full promise of simulation is constrained by the lack of a robust, automated, and embedded assessment process that can enhance the effectiveness of simulation as a training method and reduce instructor manpower requirements.

This current method of training using simulation is sub-optimized because existing technologies have not been sufficient to automatically assess performance of complex tasks and provide feedback to the instructor and student. The automated performance assessment of complex tasks is challenging because it involves the detailed understanding and modeling of how experts think (Ref 2). Assessment of performance is very challenging in non-linear simulations where more than one pathway to success or failure may exist and solutions to this problem require innovative solutions in the modeling process. There are ranges of actions that a student can take which results in an acceptable demonstration of proficiency. Much of the difficulty lies in interpreting what actions mean in the broader context of the task (rather than each discrete event being "right" or "wrong") (Ref 3).

The current "state of the art" simulation system for providing immediate feedback is the intelligent tutoring system (ITS). Most existing intelligent tutoring systems are built for training tasks which have discrete linear, "right" and "wrong" actions associated with them. However, some prototyping has been done in the field of intelligent tutoring for complex systems, (e.g. ship handling training) demonstrating that complex training tasks can be successfully accomplished in a synthetic environment using an ITS. Further, this prototyping suggests that the instructor-to-student ratio can be reduced from 1:1 to 1:2 or greater (Ref 1). Research has shown that an automated assessment system could greatly expand the current capability of an ITS and further reduce instructor requirements (Refs 2 and 3).

An innovative approach is needed to develop a technology that can interface with existing simulators for the purpose of automatically monitoring student performance, identifying assessment-relevant aspects of the students' actions, automatically feeding the information into an assessment system, alerting an instructor to potential student knowledge or skill deficiencies, and allowing the instructor to engage real time (in situ) or after action and correct these issues before a student "goes off track" and negative training results. Such a technology solution must capture what is normally recorded through visual observation based on instructor subject matter expertise and personal bias. So that multiple students can be trained simultaneously by one instructor, instead of the current 1:1 instructor-to-student ratio, the goal is 1:6 with a threshold of 1:3. The technology solution must provide a detailed skill assessment, require minimal intervention by an instructor, and require minimal instruction for individual use.

PHASE I: The small business will identify and define functionality, feasibility, and concepts for a training module that can function in a simulated environment which would reduce the amount of required instructors per student during simulator training and would include a summative report of student performance and feedback. Required Phase I deliverables will include a determination of the technical feasibility of the concept, a development of incremental approaches for achieving this goal, and development of a detailed analysis of predicted performance including instructor manpower reductions. The company will provide a Phase II development plan with performance goals, key technical milestones, and technical risk.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype system to be targeted for integration with the Conning Officer Virtual Environment (COVE) ship handling trainer or similar ship handling trainer for evaluation at Surface Warfare Officer School (SWOS). Detailed interface requirements for COVE and the Conning Officer Ship handling Assessment (COSA) system as well as performance standards will be provided to the business developing the prototype system. General interface information is provided via Ref 4 for development of the proposal. This prototype will be evaluated in a simulated relevant environment to determine its capability to meet the performance goals defined in the Phase II development plan. This evaluation will include an assessment of the degree to which the prototype will reduce instructor manpower requirements such that one instructor can effectively administer training to three or more students, generally prospective Officer of the Decks (OOD) and Junior Officers of the Deck (JOOD) / Conning Officers performing complicated ship handling tasks such as getting a ship underway from a pier, performing a twist, conducting a harbor transit in confined waters, coming along side a replenishment ship, or mooring to a pier. System performance will be demonstrated and evaluated by the Navy. Evaluation results will be used to refine the prototype into an initial design which will meet the requirements. The company will prepare a Phase III development plan to transition the technology to full Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for schoolhouse use. The company will develop the full module to be implemented in the COVE system. The company will support the Navy and SWOS for test and validation to certify the system for use and ensure that it meets training objectives.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial application and dual use would apply to advanced DoD training systems and possibly training systems used in commercial industry. The level of instructors required to teach complex tasks is an issue that is faced across the DoD. In this fiscally constrained environment, solutions which would reduce the amount of instructors required for training has re-use potential in all simulated training systems across the DoD. In addition to DoD, the gaming industry would be interested in innovative models that can accurately assess performance and provide feedback. In addition, the commercial maritime industry utilizes ship handling simulators similar to the technology employed for naval ship handling training. These systems also lack automatic assessment capabilities. Reducing the need for instructors through improved instructor feedback is applicable to other DoD training commands and specific improvements to ship handling training has the potential to be used in commercial shipping industry training.

REFERENCES:
1. Peters, S., Bratt, E., & Kirschenbaum, S., "Automated support for learning in simulation: Intelligent tutoring of shiphandling." 2011. Paper presented at the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), 2011. 25 April 2012 <http://ntsa.metapress.com/link.asp?id=u1m0845185n46816>

2. Iseli, M. R., Koenig, A. D., Lee, J. J., & Wainess, R., "Automatic assessment of complex task performance in games and simulations." 2010. University of California, National Center for Research on Evaluation, Standards, and Student Testing (CRESST). 25 April 2012 <http://www.cse.ucla.edu/products/reports/R775.pdf>

3. Koenig, A.D., Lee, J., Iseli, M., & Wainess, R., "A conceptual framework for assessing performance in games and simulations", 2009. University of California, National Center for Research on Evaluation, Standards, and Student Testing (CRESST). 25 April 2012 <http://www.cse.ucla.edu/products/reports/R771.pdf>

4. COVE Performance Interface Criteria Sheet. (See Additional Information posted by TPOC on 11/26/12.)

KEYWORDS: Intelligent Tutor System; training performance assessment; Conning Officer Shiphandling Assessment (COSA); training performance feedback; Surface Warfare Officer School (SWOS); Conning Officer Virtual Environment (COVE);

N131-049 TITLE: High Power Solid State Amplifiers

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop High Peak and Average Power solid-state amplifiers for Surface Navy Radars.

DESCRIPTION: This topic seeks to replace existing klystron tubes with state of the art solid state amplifiers (see references 1-4) The required innovation is implementation of solid state power amplifiers to replace high power Klystron tubes, the developed approach must replace the functionality of existing Klystron tubes through solid state amplifiers combining with minimized losses and maximized efficiency. The existing klystron tubes are exhibiting decreasing availability; they have complicated shipboard maintenance causing increased maintenance costs and performance impacts. Availability and reliability of existing vacuum tube klystrons are important issues currently impacting Navy cost and system availability due to obsolescence and diminishing manufacturing sources. The klystron is an RF amplifier used in surface search Navy radar. The Navy is seeking innovative reliable solid-state, modularized, amplifier that will provide graceful degradation capability, allow hot swapping of amplifier units, and increase critical path Mean Time Between Failure (MTBF) for the radar system.

Developer of the new amplifier may use technology such as, high power Laterally Diffused Metal Oxide Semiconductor (LDMOS) circuits or alternative innovative reliable solid-state electronics circuits, utilizing a minimum number of amplifier modules combined to approximate the output power of the klystron utilized in shipboard radars. This technology will eliminate high voltage radar transmitter components typical of a klystron amplifier. The Navy is seeking a solid-state amplifier design that will be retrofitable in existing transmitter cabinets and will be forward fit capable for new installations. Successful technology implementation will depend on radio frequency (rf) combiner technology which minimizes combining losses for maximum efficiency. Also, automatic switching of standby amplifier units, rf driver amplifiers, and dc power supplies is desirable to minimize maintenance intervention. The operational requirements of radars and the components used in the radars can vary significantly based upon frequency of the application and the physical and electrical parameters. Because of the unique requirements of the Navy, the Navy has determined that commercial radar technology does not meet Navy radar requirements. Innovation is needed to increase capability and performance of existing state of the art to enable form, fit, and function replacement of klystrons.

The new transmitter will need to demonstrate greater than 99% Transmitter Availability with one transmitter. The transmitter will incorporate Lowest Repairable Unit (LRU) Hot Swapping with Automatic LRU replacement for both final power amplifiers and driver amplifier units. Automatic failover using Standby Units will be demonstrated. Graceful end-of-life degradation shall be demonstrated utilizing automatic rf combiner impedance transformation circuitry, without interruption to transmitter radiate operation.

Additionally, innovation is needed to assure that Final Power Amplifiers, Driver Amplifiers, and Power Supplies shall be hot-swappable, thus reducing total ownership costs. For example the Transmitter is fully operating, and without interrupting the Transmitter output power, any amplifier LRU must be capable of physical removal and replacement. This capability will be performed while the unit is operating under full load without shutting down the Transmitter or adjusting any settings on the unit or the Transmitter, without incurring any damage to the LRU or Transmitter, and without any harmful rf exposure to the operator. No special tools will be required to hot-swap the LRU.

PHASE I: The company will develop concepts for an improved solid-state amplifier that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be shown by material testing, design element testing, and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the solid-state amplifier. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a solid-state amplifier for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the amplifier for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial applications includes airport weather radar systems and other than military government radars.

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[2] Hu, Bei; Feng, Yanmin; “The 1000W microwave solid state power amplifier at Ku band Radar (Radar)”, 2011 IEEE CIE International Conference on Digital Object Identifier: 10.1109/CIE-Radar.2011.6159773 Volume: 2Publication Year: 2011, Page(s): 1211 – 1214.

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Publication Year: 2010, Page(s): 1916 – 1918.

[4] Kim, Ki Ho; Lee, Yu Ri; Joo, Ji Han; Choi, Gil Woong; Kim, Hyung Jong; Choi, Jin Joo; Park, Dong Min; 2.7 - 3.1 GHz, 1.5 kW Pulsed Solid-State Power Amplifier with Automatic Gain Equalization Circuit for Radar Application Radar Conference, 2007 IEEE Digital Object Identifier: 10.1109/RADAR.2007.374404
Publication Year: 2007, Page(s): 1044 - 1048.

KEYWORDS: Klystron; LDMOS; Solid-state Amplifiers; automatic switching; MTBF; Lowest Repairable Unit (LRU); Modular solid-state amplifiers;

N131-050 TITLE: LFA and CFLA Acoustic Sensors

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO-IWS-5A Advanced Systems and Technology Office

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop detection capabilities for Low-Frequency Active (LFA) and Compact Low-Frequency Active (CLFA) acoustic sensors to address littoral environment clutter and false alarms.

DESCRIPTION: The LFA and CLFA acoustic sensor arrays are used for both active and passive Anti-Submarine Warfare (ASW) [Ref 1]. The systems were originally conceived for, and designed for use in a deep-water, low-clutter environment. Active clutter has increased as these systems have moved from deeper water to littoral environments. As more sonar systems turn to active, share the same battle space, and expand into a wider range of operating environments, performance impacts are requiring changes in the current LFA/CLFA sonar signal processor. Sources of active clutter currently degrading LFA and CLFA performance in the littoral are many, including other active emitters, strong bathymetric returns, oil exploration sources, volume and boundary interaction scattering, and marine life. Interfering noise signals impact both passive and active processing, including passive broadband and narrowband detection; active continuous wave (CW), coded pulse (CP), and multiple-pulse detection, classification, and tracking; and clutters the operator displays. This clutter degrades the operator’s ability to detect contacts of interest, and degrades automated processes that detect, classify, and track these contacts. Technology is needed to improve the performance and capability of operators.

Innovative signal processing and information processing improvements for the LFA and CLFA sensors are sought that will provide reduced active clutter and false alarms, while improving detection, classification, tracking, and displays. Signal processing improvements to mitigate clutter in the current SURTASS LFA CLFA processing string might include signal-conditioning, filtering, beamforming, waveforms, matched-filters, normalizers, feature-extractors, classifiers, trackers, and operator tools and displays. Examples of recent research that could further improve the current processing string are cited in the reference section, e.g., adaptive beamforming [Ref. 2], multi-target tracking [Ref. 3], adaptive matched filtering [Ref. 4] and algorithms related to active sonar performance improvement [Ref. 5].

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop signal and information processing concepts for improved performance in active clutter reduction that reduces false alarms and improves performance in detection, classification, tracking, and displays. The company will demonstrate the feasibility of the concepts in meeting Navy needs described above and show the feasibility of developing the concepts into a useful product for the Navy. Analytical modeling and simulation may be used to establish feasibility. Based on the results of the analysis the company will determine which concept best meets Navy needs and will provide a Phase II development plan with performance goals and key technical milestones and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop prototype signal and information processes for evaluation as needed. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for LFA/CLFA active clutter reduction using selected government furnished information (GFI) data sets. Sensor performance will be demonstrated through comparison of results from the prototype methods to current system methods over the required range of parameters. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use. It is probable that the Phase II work will be classified.

PHASE III: If Phase II is successful, the company will be expected to provide support to the Navy in transitioning the technology for Navy use in the Integrated Common Processor (ICP) program. The company will develop real-time computer code that implements the active clutter reduction technology, and associated computer integration code, for evaluation to determine its effectiveness in an operationally relevant environment. The company will assist in integrating and testing software in a real-time ICP environment, or other advanced processor build program specified by the US Navy. The company will support the Navy in test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Active sonar systems are currently in commercial use for depth sounding and commercial salvage, and are widely used for fish finding in the private sector. These systems also find use in fisheries management and university research applications. Signal and information processing that improve active sonar detection, and localization, particularly in cluttered environments, will provide a competitive edge to the developers of these systems. For example: The private Yacht industry is now using the Quinetiq Cerbebus detection system for unauthorized divers to provide greater security to yacht owners [Ref. 6]. All active systems could benefit from technologies that improve active sonar performance.

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5. Baldacci, A., Haralabus, G., “Signal processing for an active sonar system suitable for advanced sensor technology applications and environmental adaptation schemes,” EUSIPCO 2006, European Signal Processing Conference, Florence, Italy, 4-8 September 2006: http://www.nurc.nato.int/publications/pubs/2006/NURC-PR-2006-019.pdf

6. Hanlon, Mike, “First non-military diver detection system sold,” Sept. 2006, Gizmag at: http://www.gizmag.com/go/6226/

KEYWORDS: Low Frequency Active Sonar; Active Clutter Reduction; Acoustic Sensor Signal Processing; Anti-Submarine Warfare; Sources of Active Clutter; Compact Low-Frequency Active Sonar

N131-051 TITLE: Shock Tolerant, Solid State, Submersible Emergency Transmitter

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS397 Ohio Replacement Program, ACAT ID.

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop a solid state, easily reproducible, low-cost transmitter which exhibits high efficiency, long service life, and high shock survivability.

DESCRIPTION: Many Navy submersible systems have to meet the difficult and costly requirements of operating after major shock events. As a critical component of the Ohio Class Submarine Replacement Program, the Emergency Buoy Transmission System is a critical item that must work after experiencing a high shock event. The focus of this SBIR is to develop an innovative cost effective transmitter assembly that can meet high shock survivability requirements and function as a replacement for the current Emergency Buoy transmitter assembly. Innovative new technology will enable better mission performance and longer transmit windows while meeting shock in excess of four thousand g-forces. The Navy is seeking innovative high shock survivable alternatives that optimizes mission performance, cost savings, service life (low maintenance) and evolves the most current technology available to Navy use. The technology developed under this topic would be applicable to Ohio Class and Ohio Replacement submarines as an upgrade to the existing Emergency Buoy Transmission System.
Due to high shock requirements, the existing transmitter has a highly integrated design and layout that makes it difficult and costly to refurbish and upgrade individual components. The Navy has determined that upgrading some transmitter components is no longer feasible or economically practical. By developing an innovative approach to better integrate current digital and/or analog technology into a new buoy transmitter assembly, it may be possible to increase longevity and reduce lifecycle cost for the overall system. Most current transmitter technologies operate in the gigahertz range rather than the desired much lower megahertz frequency ranges (see references 1 and 2). In addition, there are several technical challenges involved with using current commercial technology including the high shock rating, required reliability and long service life (40 years with low maintenance). Innovation is needed to not only develop a transmitter that is highly shock survivable but can also operate in the much lower megahertz frequency ranges. The development of a transmitter that takes advantage of open architecture to enable flexibility regarding changes in technology in the commercial sector, particularly in the integration of high shock rated components, is of particular interest (see reference 3). Furthermore, development of smaller transmitters can also allow for innovative shock mitigation techniques that can be useful.

The transmitter concept and its required assembly should fit within a 13.5 inch diameter and 12 inch length space. Also, the concept should not exceed a maximum weight of 44 pounds. The full power transmission (60W) should be sustainable for more than 48 hours (goal is 72 hours). The transmitter assembly must meet extreme structural, shock and vibration requirements of references 4 and 5. The system will be required to survive in extreme weather conditions and rapid changes in temperature. Temperatures range from -40 degrees C to as high as +60 degrees C due to the operational environment for the mission. The transmitter must also be able to accept a preselected message as an input from the existing programmer as a primary function. The message is transmitted on a Continuous Wave (CW) signal on 4 sequential frequencies between 6 and 18 MHz. Off line power draw must not exceed (20µA).

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for an improved Emergency Buoy Transmission System that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the Emergency Buoy Transmission System. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an Emergency Buoy Transmission System for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic may have commercial application in naval vessel recovery, aviation search/recovery, and commercial seismic exploration.

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1. Duym, Wade, “Effects of Digital Avionics Systems on the Survivability of Modern Tactical Aircraft.” Naval Postgraduate School, Master’s thesis, June 1995.

2. Lindenmeier, H., Hopf, J., Reiter, L., Daginnus, M. et al., "A New Design Principle for a Low Profile SDARS-Antenna including the Option for Antenna-Diversity and Multiband Application," SAE Technical Paper 2002-01-0122, 2002,

3. Kelsic, Reddick, Tandy and Hackel “Adhesive Characterization and Testing for Cryogenic, High Shock Electronics Applications

4. Mil-S-901D, Shock Test, High Impact, Shipboard Machinery

5. Mil-STD-167-1A, Mechanical Vibrations of Shipboard Equipment

KEYWORDS: Emergency buoy transmitter; pressure switch; cable; shock-resistant emergency transmitter; high shock rated transmitter components; transmitter life in extreme conditions; Commercial Off The Shelf technology for transmitters

N131-052 TITLE: <u>Development of Algorithms for Characterizing Interleaved Emitter Pulse Trains with Complex Modulations</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

OBJECTIVE: The objective is to develop a scanning receiver capability that infers or interpolates missing pulse data from noncontiguous pulse clusters, regardless of modulation complexity, to improve Navy Electronic Warfare (EW) systems.

DESCRIPTION: The process of identifying Radio Frequency emitters, such as surface ship radars and missile seekers, for current Navy EW systems is very dependent on the separation or de-interleaving of overlapping pulse train signals. Current as well as new proposed techniques require that the pulsed data be collected in contiguous sets or blocks. This requires the receiver to be tuned to the emitter frequency for extended periods of time (Ref 1). A channelized receiver could be used but their cost makes this prohibitive for the frequency coverage required. Scanning receivers are therefore used. A major problem with these is that they can only sample the desired signal for a relatively short time before they must be tuned to another frequency; if they dwell too long at a particular frequency, probability of intercept will increase. The Navy has a need for a low cost technology that identifies RF emitters utilizing scanning receivers that obtain the same performance levels as wideband receivers.

The new technology needs to infer or interpolate the data that is not detected when the scanning receiver is tuned away from the signal of interest, causing missing data (Ref 2, 6). An intelligent system, such as a neural net or genetic algorithm, if trained properly, may be able to infer or interpolate the missing data since even the most complex modulations show, even if only statistically, some unique characteristics that current processing methods do not detect. Genetic and Neural (Ref 3, 6, 7) refer to the application of biological principles to programming schemes and methods. The application of these processes to this topic has not yet been developed, only speculated upon (Ref 3, 4, 5). This technology will address the Navy need of reducing operating and maintenance costs.

PHASE I: The company will develop concepts for an improved scanning receiver that will develop processing techniques to infer or interpolate, missing pulse data from noncontiguous pulse clusters regardless of modulation complexity and that meets the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation as appropriate. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an improved scanning receiver for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Radar and communications systems can also use this technology to enhance their performance and economize on hardware required. Immunity to fading and other signal disruptions would also be enhanced. Cell phone, airport, weather, and automobile industries would benefit from this technology.

REFERENCES:
1) Wiley, Richard G. “ELINT: The Interception and Analysis of Radar Signals” Artech House, Norwood, MA, 2006.

2) Haykin, S. and Thomson, D. “Signal Detection in a Nonstationary Environment Reformulated as an Adaptive Pattern Classification Problem.” Proc. IEEE, 1998. 86(11), 2325–2344.

3) Nikias, C. L. and Petropulu, A. P. Higher-Order Spectral Analysis: A Nonlinear Signal Processing Framework. Englewood Cliffs, NJ, USA: Prentice Hall, 1993.

4) Nikias, C. L. and Shao, M. Signal Processing with Alpha-Stable Distributions and Applications. New York, NY, USA: Wiley-Interscience, 1995.

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6) Black, D. C., Sciortino Jr., J. C., and Altoft, J. R. “High-accuracy, Low-ambiguity Emitter Classification Using an Advanced Dempster-Shafer Algorithm." PROCEEDINGS-SPIE THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING. 2004.

7) http://en.wikipedia.org/wiki/Genetic_programming

KEYWORDS: De-interleaving Radio Frequency signals, concurrent signals, scanning receiver, data interpolation, neural net, genetic algorithm, channel receiver

N131-053 TITLE: Sprint Speed Capability for an Antisubmarine Warfare (ASW) Training Target

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS404, Undersea Weapons Program

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop a propulsion system that will increase maximum speed of the Expendable Mobile ASW Training Target (EMATT) from 8 knots to 14 knots.

DESCRIPTION: ASW training is obtained most effectively when air, surface and subsurface platforms and their ASW SONAR crews train in the operational environment in which they would be asked to locate enemy submarines. Training against live submarines is costly and most often not available. Mobile ASW training targets fill this critical training asset. To effectively counter current and future underwater or undersea threats Naval forces must be trained with new and sophisticated technology that simulate real world conditions and scenarios. Development of a new target propulsion system that can reach a sprint speed of 14 knots is necessary and vital. Sprint speed capability on training targets provide tactical training advantages while also emulating more realistic and dynamic maneuvers of todays’ modern submarines. At present, the current MK39 Expendable Mobile Anti-Submarine Warfare (ASW) Training Target (EMATT) has a max speed of 3 to 8 knots and are incapable of achieving this sprint speed. The EMATT is designed to be launched Navy Air ASW platform and therefore is packaged in a Sonobuoy Launch Container; the EMATT therefore is “A” size which is 4.85 inches in diameter and 3 feet long and hydrodynamically torpedo shaped. The deficiency in the current propulsion system is tied to two (2) main components; the custom built Li SO2 batteries pack that generates 40Volts for the operation of the electronics system and a brushless DC motor. The innovative challenge of this SBIR lies in the design, development, and integration of a new propulsion system (high efficiency motor and energetic and safe battery) that allows the EMATT to operate hydrodynamically stable in depth, heading while achieving a sprint speed of 14 knots and a sustained variable speed of 3 to 8 knots. High energy fuels used for weapons systems are unacceptable propulsion/power options for this project because they would not meet storage and launch requirements for US Navy aircraft. The battery must meet stringent naval safety requirements contained in Reference 4.

Current technology has advanced beyond the custom built LiSO2 battery and brushless DC motor currently in use by the Navy. Reference 1 provides insight into the advantages and savings associated with the use of high efficiency motors; for example, lower cost, energy efficient, and better reliability than the current motor. Advances in current battery technology and evolution are contained in Reference 2; advances reflected in the reference have surpassed the technology being used in the present target system.

PHASE I: The Company shall develop concepts for a candidate propulsion system that meets the speed requirements of 3 to14 knots, and safety requirements discussed in the project description. The investigation should explore propulsion systems for “A” size target and propose an alternate extended length “A” size system, if it is felt the requirements are unattainable in the standard “A” size form factor. Stable hydrodynamic top speed and system safety are the primary emphasis of this SBIR topic. The company shall report how the candidate propulsion system meets the SBIR project description requirement and shall provide design data and analysis to substantiate it. The Company shall report how the candidate propulsion system can be integrated into the current EMATT target system to meet future navy training needs. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for a sprint speed propulsion system. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will develop a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a sprint speed target for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: With an improved propulsion system that provides increased energy and power for longer and more sustain periods; the targets system has viable commercial application in areas of underwater data collection, oil samplings and other containments from waterways, oceanography, and profiling

REFERENCES:
1. “High Efficiency Motors”, EnergySC, South Carolina’s Energy Resource. 19 April 2012. <http://www.energysc.org/downloadables/high_efficiency_motors.pdf>.

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5. Cutaway photo of the Mk 39 EMATT (uploaded in SITIS 12/14/12).

KEYWORDS: Propulsion Systems; High Efficiency Motor; Sprint Speed;Target Systems; AntiSubmarine Warfare; Battery Safety

N131-054 TITLE: <u>Advanced Shipboard Mission Payload Handling System</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501, Littoral Combat Ship Program Office

OBJECTIVE: The objective is to develop a remotely operated, mobile shipboard mission payload handling system common to the Littoral Combat system (LCS) seaframes.

DESCRIPTION: The Navy Littoral Combat Ships (LCS) are light weight/high speed vessels that are designed to perform a variety of missions, currently including Mine warfare, (MW), Surface Warfare (SW), and Anti-submarine Warfare (ASW). Reference (1), slide 4, provides a graphic representation of the following description of Mission Packages, Mission Modules, and mission payload. Mission Packages, developed to execute specific missions, include Mission Modules. Mission Packages also include support aircraft. The Mission Modules are loaded onto the two classes of LCS seaframes: Freedom and Independence. Mission Modules include unmanned sea vehicles, and support equipment, including ISO twenty foot equivalent unit (TEU) containers and flat racks. A flat rack is an ISO container base without walls or top. Mission payloads, the focus of this topic, are stored within ISO support containers or on flat racks. Payloads are sensors, such as the AQS-20A towed sonar, or similar equipment. When an operation in support of a mission is to be carried out at sea, payloads are moved from their stowage place in an ISO container or flat rack to the place of use. When the operation is complete, the payload is returned. Payloads may also be moved for repair or maintenance. Safe, efficient movement of payloads is critical to being able to meet mission requirements without damage to materiel or injury to personnel. The list of payloads that needs to be handled is not static. New payloads for current missions and for future missions are highly likely to be developed. Payloads can be of different shapes, such as rectangular or tubular. Some are lifted from the bottom, and others are picked up from the top. The goal of this topic is to develop a remotely operated, mobile, adaptable and upgradable system that can be used to handle a variety of payloads under one ton on both seaframes, that can compensate for limitations of the currently used handling systems, and which includes basic automatic fault detection, isolation and recovery (FDIR) capability.

The current commercial payload handling systems on the LCS seaframes were selected to be compatible with specific seaframe designs and features. The current systems are: pallet jacks, used on both seaframe variants; fork truck, used on the Independence variant; overhead gantry crane, used on the Freedom variant. These technologies do not provide a common, cost effective payload handling system common to the seaframe variants and adaptable to handling a variety of payloads. These handling systems are able to transport payloads within the ship, from container or flat rack to point of use and back, but are not compatible with all LCS handling system objectives, in particular: the ability to maneuver payloads within tight space constraints when in close proximity to the ISO containers and mission vehicles; the ability to position payloads inside the containers; and the ability to adapt to evolving Mission Package configurations. These limitations result in time consuming and labor intensive operations to transfer payloads. Additionally, supporting three separate payload handling systems that perform one function is inefficient. The use of multiple mission payload handling systems increases crew training requirements and logistic support costs. If one of the three systems fails, currently no backup is available. Providing at least two advanced payload handling systems per ship will create desirable redundancy to circumvent this problem. While, ideally, the desired system would replace the three currently used handling systems, in reality, in some situations, the advanced handling system could hand off or pick up a payload to or from one those systems. A flexible payload handling system would keep the need for such exchanges to a minimum. The system should be low cost to produce, maintain, and modify for operation on the two LCS seaframes with their Mission Packages.

Reference (2) points out those limitations similar to those of the three currently used handling systems exist for Navy-wide shipboard cargo movement in the handling and breakout of containers and in the labor intensive requirements for rigging. Reference (3) indicates that commercial automated, material handling systems are often considered to be too inflexible to be easily reconfigurable and adaptable because reconfiguration is time consuming and expensive with functionality being spread over several networks (e.g., electrical, mechanical, information), each of which must be changed individually. In commercial shipping, packing and unpacking items from containers or flat racks is not done in the constrained shipboard environment characteristic of the LCS seaframes; therefore commercial systems do not provide the capability required to handle Mission Package payloads. The innovation required for this topic is to develop a payload handling system that is 1) compact and maneuverable within seaframe access ways/clearances; 2) highly reconfigurable to be compatible with the payloads of current and future Mission

Package systems; 3) able to reach into ISO containers and in and around mission vehicles with minimal impact from obstructions; and 4) lightweight to be compatible with seaframe decks and overall shipboard weight requirements.

A key challenge is coming up with a design for a high strength-to-weight ratio system to minimize deflections during lifts. Developing the desired handling system involves several considerations, which include the following: (1) The system should have commonality to both LCS-1 and LCS-2 seaframes. (2) The system should contain its power source and be remotely operated by one person. (3) For safe operations, the basic FDIR capability should identify the location of a fault and shut the system down if necessary. (4) For minimal impact on overall ship weight, the system should weigh less than 1500 pounds and should have a deck load of less than 150 pounds per square inch when carrying a payload. (5) The system should be adaptable to different "maps" of the mission bay space with their payload lift and drop locations, which depend on individual mission package configurations. (6) The system should operate within close clearances that constrain maneuverability. It should be able to maneuver to all locations at the front of a container and around the payload destinations. Reference (3) provides additional information that companies should consider in developing an advanced payload handling system that meets the objectives of this topic.

Future spiral development of the payload handling system is envisioned to include real-time inventory capability that includes location identification, optimization and control of inventory, and synchronization with on-board inventory systems. Complexity of FDIR will increase with the progression toward an autonomously functioning, robotic, mission payload handling system. These developments will not be funded under Phase I or II and, once developed may be provided by the Government or by commercial sources. Their possibility should be taken into account in designing the system. For example, space should be allocated for additional microprocessors.

PHASE I: The company will develop concepts for an advanced mission payload handling system that meet the objectives outlined above. The company must demonstrate the feasibility of the concept. Modeling and simulation should be used to establish feasibility. Establish and assess the trade-offs made in developing the concepts. Provide a final concept for an advanced shipboard mission payload handling system. The small business will develop a Phase II development plan that includes key technical milestones and will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan and a review of existing shipboard installations configurations, the company will develop a full-scale, or near full-scale, prototype shipboard mission payload handling system. The system's performance will be evaluated in land based tests and simulated shipboard environment against the Navy performance goals using simulated full-scale or near-full scale mission modules and payloads. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If the Phase II effort is successful, the company will develop a ruggedized preproduction handling system. The company will be expected to support the Navy in transitioning the technology for Navy use. In coordination with the Navy, the company will support full-scale shipboard evaluations to determine handling system effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use. The company will provide a final design and fabricate initial units to be integrated on LCS seaframes via the LCS engineering change process.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The shipboard mission payload handling system will have industry applicability due to its light weight and compatibility with ISO commercial standards, which would facilitate handling materiel and payload in austere locations. Additionally, it should be applicable to other Navy Programs which may utilize ISO containers (e.g. JHSV Program) and to other DoD organizations (Army and Marine Corps) that utilize ISO containers in austere locations.

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3. “Technology Roadmap Meeting the Shipboard Internal Cargo Movement Challenge Consensus Recommendations of the U.S. Shipbuilding Industry” National Shipbuilding Research Program, NSRP Report #AMT-RG01112-4001; http://seabasing.nsrp.org/documents/Technology_Roadmap.pdf, section 3.4.

4. “Information Applicable to the Development of An Advanced Mission Payload Handing System for LCS Seaframes,” Document to be provided on SITIS after Pre-release.

KEYWORDS: LCS mission modules; material handling system; mission payload; remotely operated system; adaptable handling system; fault detection, isolation and recovery (FDIR)

N131-055 TITLE: Airborne Contact Cueing for Panoramic Imagers

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS435, Integrated Submarine Imaging System (ISIS), ACAT IV

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop innovative concepts for an algorithm to detect airborne contacts within a suite of panoramic image data. The algorithm would alert the operator to the possible contact for more detailed investigation.

DESCRIPTION: The Navy is developing a new panoramic imaging submarine mast. Currently, the Navy does not use an automated algorithm for aircraft search, but has operators manually scanning the horizon by rotating a non-panoramic mast. The Navy desires an innovative automated algorithm to detect aircraft within the video imagery with a very low false alarm rate in real time. (See References 1,2 & 3.) Some existing state of the art security systems that employ advanced algorithms in pattern matching, contrast detection, and motion detection may be applicable. Given that the data load is 20 times greater than production systems today, the algorithm should be highly parallelized such that it could be integrated into a parallelized image processing stream running on parallel processors as a portion of the processing code that builds the panoramic image. A panoramic imager in this mast will collect data over a wide range of vertical elevation and 360 degrees of azimuth. The amount of data collected will be in excess of 100 megapixels per frame, and 30 frames per second for visible data, and 25 megapixels per second for infrared data. The algorithm must be able to detect and cue for an operator moving aircraft using the smallest number of pixels and frames possible. Aircraft include small propeller patrol aircraft, fighter aircraft, and helicopters. Aircraft could be fast or stationary, seen against a background of sky or cloud, and search could occur during day or night.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for the algorithm described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will implement a prototype for evaluation against synthetic data, which the Navy will assist in providing. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for aircraft detection. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an algorithm for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Dual use applications of these algorithms would include security systems, many of which are starting to use panoramic imagers.

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2. McCandless, JW. "Detection Of Aircraft In Video Sequences Using A Predictive Optical Flow Algorithm", Optical Engineering, 1999, 3: 523-530. <http://isis.arc.nasa.gov/McCandless/oe.pdf>.

3. Hauser, Gregory;Manic, Milos, "Neural Network Real Time Video Processor for Early Aircraft Detection", University of Idaho, 2009.
<http://husky.if.uidaho.edu/pubs/2009/ETFA09_HauserManic_NNaircraftDetection.pdf>.

KEYWORDS: Panoramic imaging; automatic detection; parallel algorithm; aircraft detection; video processor; naval imaging

N131-056 TITLE: <u>Advanced Tactical Missile Radomes</u>

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO IWS 3, Navy Surface Ship Weapons

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to develop materials and associated manufacturing methods for advanced tactical missile radomes that achieve requirements for electrical, structural, and thermal performance.

DESCRIPTION: Radomes on tactical missiles have exacting requirements for electrical, structural, and thermal performance (Ref. 1, 2, 3). The flight environment subjects the radome to severe thermal shock, high temperatures, and possible encounters with hydrometeors (Ref. 4) and other particles such as sand. Polymer matrix composite materials are used on radomes for lower-speed vehicles; however, missiles flying faster than Mach 2 for long flight times experience high temperature increases. Materials that are stable at high temperatures (i.e. radome ceramics) are used for radomes under these extreme conditions. Current materials include slip cast fused silica (SCFS) and Pyroceram (a glass-ceramic material manufactured by Corning). These current materials offer marginal resistance to rain impact and little growth potential for extending missile flight speeds and times. Future missiles will exceed the current standards and will require improved radomes that meet the new standards.

Future missile speeds will exceed Mach 4+ and their flight times will be longer, exceeding ninety seconds. New materials and low-cost manufacturing methods are sought for radomes to meet the extended capabilities of these future missiles, and improve survivability and performance in severe environments such as those produced by weather conditions. New radome materials will require a low and thermally stable dielectric constant (less than 5, approximately 3 preferred), low loss tangent (less than 0.01), high strength, thermal stability, and high thermal shock resistance. They should also provide a hermetic seal (preventing diffusion of water into the radome cavity) and resistance to degradation by impact with particles, including hydrometeors and sand, while in captive-carry and free flight regimes. One of the challenges encountered in developing radome materials is simultaneously addressing all of the requirements. For example, increased porosity may lower dielectric constant, but reduces particle impact resistance. Innovative uses of multiphase materials, ceramics, ceramic matrix composites, coatings, and structures may provide ways to address the suite of requirements.

In addition to materials development, it is necessary to address all aspects of the radome. Some of these include attachment to the airframe, integration of possible tip inserts, and manufacturing processes. Low-cost manufacturing methods, which produce radomes at high precision, are required. Total production numbers may range from hundreds to tens of thousands, at rates up to 100 per month.

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The company will develop concepts for improved radomes that meet the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be shown through material testing, and analytical modeling. Pilot experiments demonstrating feasibility of producing radome shapes will be conducted on the most promising compositions. Sub scale or full-scale/sub-section rough prototypes will be produced and suitability of the proposed materials and processes will be evaluated by a combination of laboratory data and numerical modeling. The company will provide a Phase II development plan with performance goals and key technical milestones and that will address technical risk reduction.

PHASE II: Based on the results of the Phase I and the Phase II development plan, the most appropriate material composition and approach will be scaled-up in batch size. The company will produce article prototypes (sub-scale or sub-section) for evaluation as appropriate and will produce a scaled prototype after testing and validation of the articles, meeting the performance goals defined in the Phase II development plan and the Navy requirements for radomes. Uniformity of properties of the full-scale and sub-scale prototypes will be evaluated by the use of non destructive methods. Additional modeling will be conducted on a notional radome design, predicting survival and proper functioning of the radome through a notional flight. A manufacturing plan and development plan will be prepared. The company will prepare a Phase III development plan to transition the technology to Navy use. It is probable that the work under this effort will be classified under Phase II.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a radome for a Navy tactical missile for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the radome for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The combination of properties required for tactical missile radomes is somewhat unique, and there is little potential for commercial applications requiring the exact combination; however, there are domestic applications for ceramic materials and structures using a subset of the required radome material properties. Generally, the low dielectric constant and low loss tangent may be exploited in microelectronics, and the high temperature structural properties may be exploited in a variety of engine applications.

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4. Progress in Aerospace Sciences, Volume 47, Issue 4, May 2011, Pages 280-303.

KEYWORDS: Radome; radome ceramics; ceramic composite; dielectric; missile radome; thermal shock; hydrometeor

N131-057 TITLE: Solid-State Modulator Replacement of Tube-based Modulators

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 2, Above Water Sensors

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OBJECTIVE: The object is to develop a solid-state switch modulator for the SPY-1 Radar Cross-Field Amplifier (CFA) Final Power Amplifier (FPA) cabinet.

DESCRIPTION: This topic seeks to replace existing Switch Tubes with state of the art solid-state amplifiers (see references 1-4). The required innovation is to develop solid-state power amplifier circuits to replace current high power Switch Tubes. Current Switch Tubes use vacuum tube technology. Vacuum tubes use high power, and manufacturing resources are diminishing. Final Power Amplifier (FPA) sub-assemblies (Electronic Switch, Electronic Switch Driver, and Electronic Switch Driver Power Supply) use vacuum tube technology and have been identified as three of the top ten failure items. This is a significant contributor to total life-cycle costs of the SPY-1 radar. Vacuum tube technology is being replaced by solid-state technology in government and industry. The Navy is concerned that switch tube amplifiers and other high cost FPA components including switch tube sockets, spark gaps, high power transformers and other FPA-unique electronics used in the FPA are becoming obsolete. The Navy needs to reduce life-cycle costs of the FPA.

The Navy is seeking innovative solid-state solutions to address the costs through delivery of individual Lowest Repairable Units (LRU). A high level of design-for-repair success may include the use of soft potting material, where required, to insulate high voltage components. Optimum design-for-repair may include no potting materials; however, form, fit, function, space and thermal constraints may not allow for a potting-free design.

The solid-state switch tube replacement must be robust enough to meet current performance standards. Standards that need to be considered in the design should include arcing of the Cross-Field Amplifier (CFA) including high frequency transients. Both the arc sensing and protection circuitry must be included in the design, including Transient Voltage Suppressors on all low voltage logic and control circuitry. Upon capture of arc fault data, the design must remove current from the remainder of the pulse or, in other words, truncate the pulse. The design must be capable of reliably switching high voltage up to 20,000 volts (nominal CFA operating voltage is between 12.2 to 13.6 kV), and regulating the CFA pulse currents to between 22 and 25 amperes (optimum 22.7 amperes). The pulse top current must be flat within +/- 0.1 amperes beginning 1 microsecond after the leading edge of the pulse. The rise time and fall times of the cathode current pulse must be adjustable and controllable by the new design to match the

CFA operating requirements of approximately 75 to 125 nanoseconds cathode current rise and fall time. The CFA contains approximately 80 pico-farads of capacitance, for simulation purposes of capacitive charging current. The CFA cathode voltage rise time is between 80 and 130 kV/microsecond (tangent line at 70% point), and the cathode voltage fall time is between 100 and 200 nanoseconds (100% to 80% point).

The Phase I effort will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided as GFI to support Phase I work. The Phase II effort will likely require secure access, and the contractor will need to be prepared for personnel and facility certification for secure access.

PHASE I: The contractor will develop concepts for a solid-state switch tube replacement that meets shipboard application requirements as presented in the description. The contractor will determine the feasibility of their innovative technology to meet Navy needs and will conduct analysis that shows their technology can transition into useful products for the Navy. Feasibility will be established by material and/or design element testing and analytical modeling or a combination of these approaches as needed to assure feasibility of their potential follow-on Phase II. The company will provide a Phase II development plan with performance goals and key technical milestones. The plan will also address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the contractor will develop a prototype for evaluation to determine the capability of their technology to satisfy the performance goals defined in the Phase II development plan and the Navy application requirements for the solid-state switch tube replacement. The performance will be demonstrated through prototype evaluation and modeling and/or analytical methods for all application performance parameters including electrical, mechanical, and thermal performance, maintenance and reliability. Evaluation results will be used to refine the prototype and generate an initial design that will meet Navy requirements. The contractor will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: If Phase II is successful, the contractor will support the Navy in transitioning the technology for Navy use. The contractor will develop a solid-state switch tube replacement for testing to determine its effectiveness in, and suitability for, an operationally relevant environment. The contractor will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications of CFAs are limited to airport and other weather use radars. These radars use CFAs because they are needed for high-power radar applications. CFAs have power output capability as high as 10 megawatts. CFAs are primarily used in the Navy to support radar systems used on the AEGIS weapons systems.

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4. Whitaker, J. Power Vacuum Tubes Handbook. Second Edition. Florida:CRC Press LLC, 1999.

KEYWORDS: Switch Tube; Solid State Modulator; Electronic Switch Driver; Power Amplifier; solid state amplifier; cross-field amplifier

N131-058 TITLE: <u>High Pressure Diver Breathing Gas Supply System</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: NAVSEA 00C, Navy Diving Program Office

OBJECTIVE: Develop a small, high pressure (7,000-10,000 PSI) diver-worn air flask (tank) and associated regulator that can provide equal or greater breathing gas supply to current systems but with a smaller physical form.

DESCRIPTION: The current air flasks authorized for use by Navy divers for SCUBA diving hold approximately 80 cubic feet of air at 3,000 psi, weigh approximately 40 lbs and measure approximately 2.5 feet long by 8 inches in diameter (ref 1). These are typical of the standard flask found in commercial and recreational diving. This flask is normally carried on the back of the diver. While the duration of that air supply is dependent on the depth of the dive and the exertion of the diver, one normally expects anywhere from 30 minutes to an hour of air supply from a single tank.

The current technology that is able to produce 10,000 psi cylinders and regulators results in systems that are too large and heavy to be used in diving applications. Any benefit that could be realized from the use of these higher pressure systems would be offset by the added size and weight of the equipment needed for containment. In addition, portable high pressure air compressors are currently only capable of providing gas up to 6,000 PSI. The Navy is seeking innovation in tank fabrication, tank materials and regulators to support the higher pressures that will allow production, storage and deployment of these high pressure diving systems (ref 2).

Development of a high pressure regulator and hose assembly would be required to reduce the flask pressure from the stored 10,000psi to a breathable pressure of approximately 140psi. The regulator would need to be small enough and light enough to be effectively used in a SCUBA diving application. This is currently not available at these higher pressures. Current regulators are limited to approximately 4500psi flask pressure (ref 3). Innovation would be required in regulators and materials to safely of support these pressure and size requirements.

Air supply is the most significant limiting factor for mission execution of a free-swimming diver. The use of multiple existing tanks by a diver, while possible to an extent, is cumbersome and significantly affects the diver’s ability to swim and work. The Navy is seeking development of a small (less than 18 inches in length and/or 4 inches in diameter), high pressure (approximately 10,000psi) flask that could hold approximately 12 cubic feet of air. Multiple small, high pressure flasks could be carried in a variety of configurations on the diver that could be more hydrodynamic and accessible than the current single tank on the back. Significant benefits could be found in Combat Diver mission areas through development of lower-profile diving equipment (ref 4 and 5). Additionally, utilizing a clustered tank configuration of smaller, high pressure tanks that occupies the same space as the current tank would enable multiple dives from a single air source or longer duration dives. This could also reduce the logistic footprint and transportation requirements by requiring smaller tanks which would increase mobility of expeditionary dive forces. The use of high pressure tanks for emergency gas supply would increase factors of safety for diving operations and enable access to missions that are currently unavailable due to air supply limitations.

PHASE I: The company will develop concepts for a high pressure air flask, regulator, and hose assembly that can be utilized by a diver as an underwater breathing gas supply system as described above. The company will demonstrate the feasibility of the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a high pressure air flask, regulator, and hose assembly prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the High Pressure Diver Breathing Gas Supply System. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including various operational environments. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop High Pressure Divers Breathing Gas Supply system for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector applications of this product mirror the various military applications such as providing large quantities of breathable air for underwater diving (commercial and recreational), firefighting and contaminated atmospheres, emergency air supply for accidents, confined spaces and aircraft, and portable high volume air supply for pneumatic tools. Any application that currently requires a stored air supply, either for breathing or performing work, can benefit by the use of a smaller, higher volume system. Small diameter flasks that provide equal or greater supplies of air than current systems may enable completely new diving rigs, submersibles, pneumatic tools and other equipment. This product would be considered a “game-changer”.

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5. U.S. Navy General Specification for the Design, Construction, and Repair of Diving and Hyperbaric Equipment (NAVSEA TS500-AU-SPN-010). http://www.supsalv.org/pdf/DiverTechManual.pdf

KEYWORDS: High Pressure Air flask; High Pressure Regulator; SCUBA tank; emergency gas supply; High Pressure Air Compression; Diving Life Support Systems

N131-059 TITLE: Very Wide Bandwidth Radar/EW Components and Characterization

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The object is to develop practical, low-loss, high-isolation passive components and associated characterization techniques for very wide bandwidth, high frequency (micro- and millimeter-wave) circuit applications. Materials, design and fabrication approaches will be developed to yield practical passive components. Innovative characterization techniques, employing photonics or other novel technologies, will be developed for improved characterization of such very wide bandwidth, high frequency passive components.

DESCRIPTION: Current research points toward future electronic warfare (EW), communications (comm) and radar systems operating over very wide bandwidths (1 - 110 GHz) with circuits employing emerging active device technologies capable of performance substantially beyond the current state of the art. These new technologies will require innovative passive circuits/components possessing superior performance characteristics (Ref. 1, 2, 5) in order to implement new system capability. Very closely associated with the new hardware itself is the characterization testing of both passive components and active devices in developing systems. Examples of active device technologies include Gallium Nitride (GaN) and graphene; and examples of passive components include transmission lines and interconnects, splitters, and hybrid couplers. To evaluate the performance of these new circuits and components, test circuits employing innovative technologies and components will also be required. Characterizing the high-performance devices will require new techniques that are well beyond the capabilities of conventional methods being used. The Navy seeks passive components and associated characterizations techniques (Ref. 3, 4) that enable improved testing of emerging very wide bandwidth, high frequency technologies.

This topic identifies four important focus areas (A-D below). Projects must address innovative technology within at least one of these focus areas:

A. Generating and sourcing very wide bandwidth signals that characterize emerging active devices and passive components has significant challenges. Commercially available signal generators are limited to less than 70 GHz and provide low power. Due to inherent measurement system losses, the signal power is further reduced prior to reaching the device under test (DUT). The Navy seeks capability to source signals up to 110GHz through one connection, while delivering maximum power to a DUT (Ref. 3, 4).

B. Sensor systems are increasing in capability and performance. The need to source them with complex, very wide bandwidth signals continues to increase with their improvements. Conventional approaches to providing broadband modulation from low frequencies to 110GHz with sufficient power are inadequate. Challenges associated with power loss, isolation and matching exist. The Navy seeks capability to source a modulated signal up to 110GHz over a single connection and provide at least 20dBm of power to the DUT. Low cost, low loss and small size are all factors to consider in development of this technology. They will simplify shipboard maintenance and decrease maintenance costs, while increasing performance. Low loss is expected to contribute to improved energy efficiency.

C. An ensemble of passive components is needed, having optimized materials, low-cost fabrication methodology and accurate high-fidelity designs (Ref. 1, 2, 5). The ensemble of components must perform several functions well. Refer to the DoD SITIS website for basic performance of a minimum ensemble of components.

D. Novel characterization techniques are needed for passive components operating over very wide bandwidth, at frequencies up to 110 GHz. Application of the same techniques to active devices is a plus. Photonic approaches developed under this topic are expected to improve very wide bandwidth characterization and performance of developing shipboard systems. Initial development of novel characterization techniques will focus on demonstrating an industrial version of the technique. Engineering development of the technique should culminate in a deployable version that will simplify shipboard maintenance and decrease maintenance costs while increasing ship systems performance. The end of effort should be a new characterization technology suitable for deployed system use and insertion.

The Navy will provide typical data for demonstration of the effort without requiring secure access.

PHASE I: The contractor will develop concepts for very wide bandwidth, very high frequency passive components and characterization techniques that meet the requirements of one or more of the focus areas (A-D) described above. Contractor will demonstrate feasibility of the concepts to meet Navy needs, and will show that the innovative concepts can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing critical materials or design elements, subscale prototyping and analytical modeling. The small business will provide a Phase II development plan having performance metrics and goals, key technical milestones, and that identifies a strategy to address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, contractor will develop prototypes - passive, very high bandwidth components, and/or a laboratory version of their novel characterization technology. Prototypes will be evaluated to determine their capability to meet the performance metrics and goals defined in the Phase II development plan and Navy requirements for very wide bandwidth technologies. Measured prototype performance will be combined with modeling and analytical methods to estimate eventual performance of an initial design in a system application. The company will prepare a Phase III development plan describing a strategy to transition their technology into a Navy system.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The contractor will develop an industrial version of characterization techniques, passive components, or photonic devices for evaluation to determine their effectiveness in a relevant operating environment. The contractor will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial application and dual use exists in military systems, other government systems, commercial systems for aperture based EW Radars, and communication. In addition, techniques and components developed will find numerous applications in commercial test equipment that is used for high frequency characterization testing.

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KEYWORDS: electronic warfare (EW); very wide bandwidth; ultra-wide-bandwidth (UWB); passive millimeter-wave components; component testing; hybrid coupler; power splitter; transmission lines

N131-060 TITLE: Subsea Long Haul Optical Transponder

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: NAVSEA PMS 485, Maritime Surveillance Systems (MSS), Fixed Surveillance

OBJECTIVE: The objective is to develop an innovative, miniaturized undersea transponder for data transmission over long haul underwater cable systems where the signal is generated from an undersea node and the use of repeaters is minimized.

DESCRIPTION: New Navy concepts of operations using Autonomous Undersea Vehicles (AUV), acoustic communications, shallow water arrays, towed sensors, environmental profiling, and trip wires all require data exfiltration and fusion to be effective. Information Dominance depends on persistent accumulation and analysis of regionally captured intelligence, surveillance and reconnaissance, meteorological and oceanographic data. Current Open Architecture (OA) concepts that enable emerging undersea capabilities recognize the benefits of maximizing the utility of deployable, persistent, undersea fiber infrastructures. Recently analyzed approaches to Maritime Surveillance Systems (MSS) and other undersea operations that support using OA and standards-based bidirectional fiber optic solutions have identified the need for ocean floor node powered data transmission.

The Navy needs to improve the performance and capability for AUV data exfiltration. The need to exfiltrate data collected by AUV, Unmanned Undersea Vehicles (UUV), etc from undersea nodes to shore has become a desirable capability for naval operations and scientific data collection. Approaches to undersea operations support using OA and standards-based bidirectional fiber optic solutions and have identified the need for ocean floor node generated data transmission. The current gap is in achieving the desired bidirectional data rates at increased distances.

The proposed transponder, in conjunction with commercially available optical amplification with Erbium Doped Fiber Amplifiers (EDFAs) and Dense Wave Division Multiplexing (DWDM), will enable oceanographic information to be transmitted from the ocean to shore over long distances. This transponder technology will support undersea distributed networking and fusion of data from multiple sources as well as enable multi-user capability using OA infrastructure at remote seafloor nodes.

Long haul undersea optical transmission systems are capable of transmitting 100 channels of 10 Gb/s optical signals over 9,000 km on a single fiber. These systems are powered from shore and typically use racks of electronics to power them. They also use repeaters to amplify signals every 40 -120 Km. (see Ref 2.) To decrease repeaters, the system generally must increase overall system end-to-end signal gain. Typical repeater-less designs seek to increase power of the optical main signal, reduce non-linear optical effects in the fiber line, improve optical fiber losses, and improve receiver sensitivity. Techniques such as suppression of stimulated Brillouin scattering (SBS), new modulation formats (Return to Zero Differential Phase Shift keying, Non-Return-To-Zero, Return-to-Zero for example), Raman amplification, and In-line Remote Pumping Amplification have emerged. (See Ref 3.) These digital modulation formats, amplification techniques, may or may not be applicable to achieve increased transmission distances at higher data rates from the seafloor than currently possible. There are many others. The goal of this topic is to determine the best combination of techniques to solve the capability gap of bidirectional data rates at distances greater than 5,000 km. Commercially available Erbium Doped Fiber Amplifiers (EDFAs), Dense Wave Division Multiplexing (DWDM), and coherent detection techniques may also apply. The undersea environment does not support cabinet size electronics and multiple repeater architectures are costly.

To support deployable undersea-to-shore data transmission, this topic seeks an efficient long-haul optical transponder that is suitable for integration in an undersea network. The goal of this network is to provide power and data connectivity to various customers or tenants. It is reasonable that the components of the network itself, the hotel, will require power and bandwidth (health monitoring for example). However, a finite amount of power is available. Therefore, it is desirable for the hotel power requirement, including this transponder, to be as low as possible. For the purposes of this discussion, 5 W would be considered low and 25 W would be considered high. The transponder must demonstrate data transmission at a minimum of 1Gb/s and an objective of 10 Gb/s over a minimum of 5,000 km and an objective of 9,000km without repeating or regenerating for a minimum of 100 km and objective of 300 km with a bit-error-rate of 10-12. The proposed approach must be compatible with US and international telecom (ITU) standards, Ethernet protocols and have a 15-year, objective, 25-year goal operational life in the deep ocean. (See Ref 1.) The size of the transponder should be similar to that of a Small Form-factor Pluggable (SFP) transceiver specified by Multiple Source Agreement (MSA) group.

PHASE I: The company will develop innovative concepts for a low-cost transponder the meets the requirements described above. It will identify how these technical solutions might be integrated into an underwater distributed network to achieve objective data rates, distances, power consumption, and minimal repeater use. The company will show the feasibility of developing concepts into transponders useful to the Navy and the feasibility of the solutions in meeting Navy requirements. The company will provide a Phase II development plan that establishes performance goals and key technical milestones, addresses technical risk reduction, and includes estimates of development cost and schedule as well as the associated cost, schedule, and performance risks. Reliability, maintainability, and availability will also be considered in the Phase II development plan.

PHASE II: Based on the Phase II development plan, the company will develop prototype transponders for evaluation that use the innovations identified and developed in Phase I. Development will include mechanical interfaces and integration with Government underwater distributed network components. Prototypes will be tested in the laboratory to evaluate performance to Navy requirements as described above. The system will be refined and the company will prepare a Phase III development plan (including reliability, maintainability, and availability (RMA) predictions) to test and prepare the system for Navy use.

PHASE III: Based on the results of Phase II and the Phase III development plan, the company will fully develop and integrate the transponder solution into an underwater distributed network node. The company will be engaged in development, testing, qualification, and certification to make the system available for Navy use. Complete system end-to-end tests will be performed on shore and at sea to demonstrate successful deployment. A manufacturing and supportability plan will be developed and will show projected production costs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology has potential commercial transition to the oil and gas industry for lowering the cost of transmission of deep ocean exploration site data, to the scientific community for enabling unprecedented ocean basin data telemetry, and to telecommunications long-haul optical transmission systems.

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KEYWORDS: optical cable systems; optical transponders; optical repeaters, repeaterless transmission systems; Raman, long-haul transponder

N131-061 TITLE: Improving Software Efficiency: Automated Program Transformation for Reclaiming Execution Efficiency (APTREE)

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop techniques, methods and tools for improving software execution efficiency and reducing software bloat while preserving the programming productivity gains offered by modern software engineering practices.

DESCRIPTION: The size and complexity of software in Navy systems has grown tremendously in recent years. The growth in software size and complexity partially comes from the rising percentage of software components in Navy and DoD systems. For example, the percentage of avionics specification requirements involving software control has risen from approximately 8 percent for the F-4 in 1960 to 45 percent for the F-16 in 1982, 80 percent for the F-22 in 2000, and 90 percent for the F-35 in 2006, and the code size has increased from about 3 million source lines of code (SLOC) in the F-22 to about 14 million SLOC in the F-35. It is expected that the percentage of software components in Navy systems will continue to grow. This growth factor is considered necessary as it provides enhanced capability and flexibility to Navy systems. The other growth factor in software size and complexity is an unfortunate artifact of modern software engineering practice which results in complexity and bloat. This growth factor is considered accidental and is a major contributor to unnecessary complexity, increase in computing requirements and vulnerability. This unfortunate side effect of modern software development practices affects most software products and is especially severe for the commercial off-the-shelf (COTS) software [1] [2]. It is also expected that a large percentage of Navy systems software components were adopted from COTS components and are not specifically built from scratch for the Navy.

Until recently software developers have relied on the increasing capacity of hardware to compensate for increased software inefficiency, but the benefits of the so-called Moore’s Dividend are running out [3]. While the number of transistors on a chip is still doubling every two years, the gain in number of transistors can no longer be used to increase individual processor performance due to insufficient instruction level parallelism in a program and a chips power dissipation limit. Instead, the gain is being used to increase the number of processors on a chip. Therefore, unless the application itself is highly parallel in nature the potential performance improvement from increased hardware capacity has reached its limit. To accommodate future computing requirements it is necessary that accidental growth be minimized. Hence, software efficiency is becoming more important.

Current software development practices (particularly reliance on shared libraries, elaborate class hierarchies, and layers of function calls), while increasing programmer productivity, also lead to software bloat and inefficient program execution. Existing compiler technology generally includes optimization options, but it neither removes unneeded or unreachable code from dynamically linked libraries nor simplifies class hierarchies. Because of this, existing technologies do not significantly reduce software bloat nor improve execution efficiency. Tools are needed to reduce software bloat and collapse software layers and thus improve software efficiency and robustness without impacting developer productivity.

The objective of this solicitation is to develop a tool which can substantially improve the efficiency and robustness of binary executables by performing whole-program optimization directly on compiled programs. A tool that successfully implements this goal will dramatically improve the way software is developed and deployed allowing program tailoring into the particular deployment environment. This can provide new optimizations available late in the development process, and even by the end user during the program installation time and beyond. This tool will provide headroom for future growth of software and the associated computing requirement and reduce vulnerability. It will also be immediately beneficial for computing environments where computing resources and power are at a premium, such as in a mobile and battery operated computing environment whose use by war-fighters is currently on the rise.

PHASE I: Architectural analysis and design of a tool for reclaiming program efficiency and reducing bloat from binary code. Develop a detailed and comprehensive plan for Phase II and minimal functionality, and minimal functionality proof of concept for Automated Program Transformation for Reclaiming Execution Efficiency tool. Identify the metrics that determine the efficacy of the proposed tool.

PHASE II: Develop a full functioning prototype of a tool which substantially improves the efficiency of binary execution. Demonstrate the efficacy of the tool.

PHASE III: The tool would be valuable for both the Navy as well as for civilian and commercial use. Besides providing room for future growth in Navy systems, it also provides reduction in power usage/requirement to current software executables. It will be very advantageous for mobile and battery powered devices where both power and computing resources are limited. It will be a stand-alone tool which can be used to improve program execution efficiency and security. Once matured, it can be integrated into software deployment process for Navy’s systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: APTREE could be a valuable tool for both the Navy as well as for civilian and commercial use. It could provide improvements in program efficiency and reduction in hardware requirements, as well as reduction in power usage/requirements to current software executables. It will be very advantageous for mobile and battery powered devices where both power and computing resources are limited. It is applicable to both general computing as well as embedded computing applications. A properly marketed and successfully developed project has the potential in the private sector as a stand-alone tool (directly marketed to computer/mobile-computing users), as part of operating system's application support, or as part of a software development environment.

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KEYWORDS: Robust software, software efficiency, efficiency reclamation, software de-bloating, binary program transformation, program specialization, program slicing.

N131-062 TITLE: Advancing the State of the Art in Artificial Intelligence for Simulation Training

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop Artificial Intelligence (AI) software that is generalized across entity-level simulation systems and can be used in training simulation to generate entity behaviors that are both contextually and tactically realistic.

DESCRIPTION: The United States Marine Corps (USMC) has been a pioneer in using commercial gaming technology for training. The current small unit training simulation is VBS2, developed by Bohemia Interactive Simulations. It is used primarily as a small unit training system in which each squad member has their own networked laptop and controls their own virtual character. A contracted role player usually controls opposing force characters, civilian characters, and friendly units. Although a human controller adds behavioral and tactical realism to virtual training scenarios, such interactions are costly which limit the number of Marines that can receive training. We are seeking solutions to develop AI capabilities to reduce the number of contracted role players required to supervise and manage simulation characters. In addition, other entity-level simulations, such as Joint Semi-Automated Force (JSAF), are used as part of the Deployable Virtual Training Environment. There is a desire to support improved aircraft Terminal Attack behaviors in support of future programs.

PHASE I: Define and develop a concept for using AI in VBS2 and JSAF to improve simulation training. The focus should be on improving the behavioral realism of the NPC while reducing the need for support personnel.

PHASE II: Produce prototype software based on Phase I work which can be set up and effectively used by minimally trained enlisted Marines.

PHASE III: The AI system may become an integrated part of the SITE Program of Record, supplementing and improving VBS2 simulation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology will have application in the commercial gaming arena, making games for entertainment more engaging and realistic.

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KEYWORDS: Simulation; modeling; artificial intelligence; training; VBS2; JSAF

N131-063 TITLE: Crowdsourcing as a Map Reduce Job

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: PMMI, MCSC

OBJECTIVE: Develop a methodology based on cloud computing for using crowdsourcing to recognize social changes or activity of immediate significance to crisis situations.

DESCRIPTION: During crises situations, whether they are caused by national disasters or regional instability, accurate and timely information is needed for mission success. Some of this information can be retrieved from existing data sources (e.g. local weather) but much needs to be reasoned about by humans (how locals will react to the insertion of forces). During the early phases of a crisis, decision makers such as Marine Expeditionary Unit (MEU) commanders are often confronted with more raw information than can be processed even if they had an organic capability to interpret the data. A capability to surge analytic efforts is needed in support of crises response in order to optimize tactical operations. Crowdsourcing is a methodology that distributes analytic efforts to a large group to create a more accurate product faster. Crowdsourcing represents a distributed problem solving model that has existed for many years but has become more effective through the use of the Internet (1). The benefits include a means to obtain information from a wider range of sources than might be present in one organization. In addition, communities can be made both contributors and beneficiaries of group team work. The power of social networking was demonstrated in the DARPA Network Challenge (2) where this challenge showed that groups can collaborate on locating moored weather balloons. It has also been shown that disclosure of problem information to a large group of contributors is an effective means of solving scientific problems (3). The value of open information sharing has been shown not only with science problems but also cultural products. The developers of Ushahidi reporting service demonstrated that citizen inputs could be collected through mobile phones and do a better job of reporting acts of violence than that achieved through mainstream media (4). Technologies have evolved to bring information together via the internet.

The evolving DoD cloud architecture, with a map reduce application construct, may be well suited to allow crowdsourcing to be used during crises response periods. To enable this capability, innovative data collection, clustering, and dissemination methods are needed (map) as well as innovation in how many inputs can be quickly reduced into actionable information automatically. The implementation of crowd sourcing as a distributed analytic capability for MEU commander assigned a crisis response mission must, however, be very different than the commercial use of this technique. The MEU commander will not have the time to sift through a large number of received responses. Rather than the manual reduce process typically used by crowd sourcers, a military response to crises requires an automated reduce process. The other innovation required for the use of crowd sourcing for crises response that must be explored by proposers is the use of crowd sourcing principals to responses received from both humans and machine analytic fusion nodes. Deriving metrics for such a map reduce task has technical risk but is foundational to the use of cloud enabled collaborative workflows.

Challenges for this topic include:
1) System recognition of questions suitable for crowdsourcing.
2) Automating the discovery of available and relevant processing nodes (which can be either humans or machines).
3) Mapping the question into parts that can be processed by distributed nodes with access to disparate data.
4) Reducing responses from the distributed nodes to a single answer.
5) Fusing human responses with responses generated from machine fusion (modeling/predictive) nodes and assigning a combined confidence score.

A matured system should be able to utilize crowdsourcing principles from within cloud architecture tenants to show that questions related to the recognition of social changes or activity of immediate significance can be answered more accurately in less time.

PHASE I: Determine the technical feasibility and develop a proof-of-concept for a prototype system that can understand the suitability of a question to distributed crowdsourcing. The concept should address the capability to: 1) automate the discovery of available and relevant human and machine processing nodes, 2) map a question into parts that can be processed by distributed nodes with access to disparate data and be able to reduce disparate responses into a single, more complete and accurate answer, 3) identify and track key technical performance parameters, and 4) demonstrate the concept in a manner that clearly shows how much risk, relative to the production of a full prototype system, has been mitigated.

PHASE II: Develop a proof-of-concept prototype system that is capable of more completely and accurately detecting social change or a significant event by using human and machine populated cloud architecture and a map reduce processing paradigm. The prototype system should demonstrate an increase in the accuracy of a produced answer relative to the assessment produced by an average node. The demonstration should use real responses from distributed human nodes. During Phase II, the system requirement may include the processing of classified data.

PHASE III: Produce a system capable of deployment and operational evaluation. The system should address all of the social behavior and significant event detection requirements of the transition program. Enhance performance over Phase II demonstration by showing increases in both the breadth of questions that can be addressed and in the accuracy and completeness in which the system can address them.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Media outlets already mine the internet and enabled social media outlets for news. The technology developed under this topic would enable these outlets to use members of social media channels to help write more accurate and complete stories to report on, using both discovered information and human responses to challenge questions. Budget realities prevent news media from being able to have reporters at all locations in the world where news of interest can occur at all times. The developed technology also has great applicability to NGOs challenged with crises response.

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KEYWORDS: Crowd Sourcing, Map Reduce, Reporting, Cloud Architecture, Distributed Processing, Collaboration, Mixed Initiative, Fusion

N131-064 TITLE: Thermal Batteries: Low Size, Weight and Power 4K Cryocooler

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective is to devise and demonstrate a small and light cryocooler capable of hosting electronics requiring a 4 Kelvin (K) operating temperature in a Size, Weight and Power (SWaP) constrained tactical environment such as Unmanned Aerial Vehicle (UAV).

DESCRIPTION: A central impediment to the tactical fielding of Nb superconducting electronics is the total lack of an extremely compact, low power, 4K cooler with the ~100 mW of lift required for an operationally exciting system for man-portable and UAV platforms, where fleet interest in new hardware is strongest. While numerous ideas of how to reduce the 4K heat load are being explored, the power and volume of 4K coolers is dominated by the lift required at higher temperatures, usually 77K where liquid N2 boils. There are no logistics issues with liquid nitrogen supplies as it is 80% of air, safe to handle, and air liquefiers already exist on larger platforms to supply breathing oxygen to pilots, etc. Thus this topic explores the possibility of small (4L is small enough for Electronic Warfare (EW) pods) closed cycle, low power He coolers running within a vented bath of liquid N2 or in contact with some other thermal battery. Trades will be required between hold time and volume/weight, adjustment of compressor design for higher density and viscosity of gas, and design of venting to handle roll and pitch of a tactical platform. The Commercial Off-The-Shelf (COTS) cryocoolers currently used for functionality demonstrations are fully closed cycle. The cold parts are about 10L in size, but the COTS room temperature compressor is over 90 lb., a cubic foot in size, and requires 1.5kW from the wall. Fully closed cycle, potentially tactical, coolers being worked reveals that >60% of the power and vast majority of weight arises from the ~77K stage. Thus attention should be paid to the possibility of going to a modular design which uses passive cooling for achieving the 77K start. The essential innovation is the off-loading of the power cost of charging the thermal battery to the platform that represents the sensor's home base.

PHASE I: Design a first prototype based on the design concept defined in the Phase I proposal. Estimate the hold time/heat lift/weight trades of proposed design. In option period further reduce technical risk and prepare to execute design.

PHASE II: After consultation with the Navy Technical Point of Contact (TPOC), finalize design of the first demonstration unit and construct at least the highest risk components. Potentially complete the first demonstration prototype and test the conformance of its behavior with the projected trade space. Then demonstrate its potential to cool to operating temperature with a simple government furnished superconducting chip.

PHASE III: Collaborate with a system integrator and a superconducting system vendor to demonstrate a combined superconducting receiver packaged on your cooler.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The prime commercial application area is the instrumentation industry. Low temperatures are well known to reduce thermal noise, making small signals easier to see. Thus, the most sensitive infrared (IR) and radio frequency (RF) sensors operate at well below room temperature, as do very low power magnets, as in Magnetic Resonance Imaging and chemical analysis tools. A cooler of the desired sorts could be used to cool infrequently used magnetometers since the thermal cycling time between room temperature and 4K will be much shorter in this sort of system than in fully closed cycle machines. Whether mobile, small volume, or both magnetic field requiring sensors or x-ray machines are candidates should be considered. Space exploration is another area that has historically utilized thermal batteries.

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KEYWORDS: Cryocoolers; thermal batteries; air liquefaction; energy efficient flash freezing; EW pods; heat capacity; modular cryocoolers; tactical coolers.

N131-065 TITLE: <u>Automating Unmanned and Manned Sensor Performance in Demanding Tactical Environments</u>

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop a fully-integrated autonomous real-time execution planning and re-planning application to maximize the utility of one or more Intelligence, Surveillance, and Reconnaissance (ISR) platforms, and dramatically accelerate the generation and understanding of the common operational and tactical battlespace picture within a set of evolving constraints.

DESCRIPTION: Varying levels of automation are being utilized, or planned for, in Navy airborne sensor systems. Critical operator time-intensive sensor functions along with the analysis of merged organic and off-board sensor information for target classification, identification, and behavioral monitoring are all being automated. With this topic, we seek to combine these automated sensor functions with a real-time, dynamic, mission route and sensor scheduling planner capable of satisfying multiple, potentially conflicting, mission constraints and objectives in a littoral operating environment. While there is substantial research throughout industry and academia into dynamic path planners, their decision logic doesn't adequately account for tactical sensor capabilities or the airspace characterization necessary for the platform to operate safely and effectively, particularly in non-segregated airspace. Furthermore, the current approaches do not yet provide a means for interpreting and acting on statements of commander's intent that have varying degrees of specificity.

This effort will focus on developing a software set of one or more real-time dynamic mission route and sensor scheduling planners for both manned and unmanned platforms. In addition to consideration of the platforms tactical sensor capabilities and the airspace characterization, the approach being developed needs to account for: (1) vehicle kinematic state and limitations, (2) restricted operating regions, (3) terrain impacts including sensor line of sight blockage, and (4) understand how decisions may impact on-station time. For this effort, the offeror may assume that sensor resource management tools and operator classification aids exist and will be integrated into a larger single or multi-platform mission execution application.

PHASE I: Provide a detailed assessment of the concept, identify key components of the integrated approach, identify robust and effective means of interacting with the product, and show how general statements of commander's intent are understood and acted upon by the application. Demonstration of these functions should be tested in simulation.

PHASE II: Continue development of the application and conduct performance testing and demonstrations using high fidelity simulations. At the end of Phase II, a real-time implementation of the software should be demonstrated (flight test preferred). The contractor is encouraged to work with platform and sensor developers in Phase II to ensure their prototype is being designed to an interface representative of the transition platforms.

PHASE III: Working with platform and sensor developers, complete the development of the real-time software, and optimize functions and operator interface for the transition platform. Test and validate performance in a representative environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Large area security with Unmanned Aerial Vehicles; automated area surveys.

"Historically, Unmanned Aircraft Systems (UAS) have mainly supported military and security operations overseas, with training occurring in the United States. In addition, UAS are utilized in U.S. border and port surveillance by the Department of Homeland Security, scientific research and environmental monitoring by NASA and NOAA, public safety by law enforcement agencies, research by state universities, and various other uses by public (government) agencies. Interest is growing in civil uses, including commercial photography, aerial mapping, crop monitoring, advertising, communications and broadcasting. Unmanned aircraft systems may increase efficiency, save money, enhance safety, and even save lives." - FAA.gov FACT SHEET UNMANNED AIRCRAFT SYSTEMS (UAS) Updated July 2011

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KEYWORDS: Automation; Sensor; Unmanned Aerial Systems (UAS); Picture; Collection; Understanding

N131-066 TITLE: Electromagnetic-Attack-Resistant Electro-Optic Modulator

TECHNOLOGY AREAS: Sensors, Electronics

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and demonstrate engineering prototypes of a wideband, high-sensitivity, high RF power handling optical modulator suitable for use in low-noise microwave photonic links associated with military and commercial antenna applications.

DESCRIPTION: Electronic systems connected to RF and microwave antennas by metal connections cannot be fully shielded from HPM and EMP signals because there must be a continuous path from the antenna to the system for the desired signals to be received. Current electronic protection devices and circuits have issues associated with insertion loss, bandwidth, turn-on/turn-off times, power handling, and lifetime. Unlike any electronic protection devices, photonics can provide complete isolation of electronics from the antenna via the electrical-to-optical and then the optical-to-electrical conversion processes associated with RF photonic transmission links. However, existing high-speed electro-optic modulators can be damaged by extremes of current and voltage [1]. A modulator that can withstand the power levels coupled into it by an antenna during an electromagnetic attack is required. The exact power and time profile is highly dependent upon the type of antenna and the type of attack, but for this SBIR topic a nominal goal is to withstand a 1-second burst of 3-microsecond pulses with a 0.1% duty cycle at 0.1 to 10 GHz center frequency, with 10 kW peak power coupled into the modulator by means of an appropriate RF coaxial cable. Because an electronic low-noise amplifier (LNA) cannot be interposed between the antenna and optical modulator in this application, the wideband modulator must have optical power handling, insertion loss and switching voltage/efficiency characteristics that support a photonic link with a noise figure <10 dB at up to 10 GHz [2]. In addition, it is desirable that the modulator recover to normal operation quickly after the end of the pulse train (<<1 mS).

State of the Art: The primary electronic protection device against electromagnetic attack is a plasma limiter. These devices still provide a continuous electrical path from the antenna to the electronics so that there is a possibility of damage if the limiter fails during the years it is installed but untested. They are also susceptible to damage at high power levels and the leading edge of a pulse leaks through. Existing high-speed optical modulators can be damaged by pulsed power levels as low as 100W, making them unsuitable as Electronic Protection devices.

PHASE I: Develop the concept and design for an electro-optic modulator and RF photonic link that can meet the cited performance levels. Validate the design with rigorous modeling and/or simple proof-of-concept experiments.

PHASE II: Develop, construct, test, and demonstrate an optical modulator and prototype RF photonic link that meets the cited performance goals. Multiple copies of the electromagnetic-attack-resistant front-end component(s) (e.g., the modulator) should be tested against a simulated attack (somewhere in the 0.1-10 GHz range) to provide, at least, a small set of statistical data. Delivery of an optical modulator prototype for independent government testing is required in this phase.

PHASE III: Build field-deployable RF photonic link prototypes and demonstrate them in operational environments against a variety of electromagnetic attack types. Transition the demonstrated technology to dual-use production and products.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The electromagnetic-attack-resistant RF photonic links developed under this SBIR topic can be used in any military or civilian antenna system where an RF or microwave receiver system must be protected from potential attack [3]. Critical civilian systems such as cellular communication infrastructures are candidates for these products.

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KEYWORDS: Electromagnetic attack, electromagnetic pulse, high-power microwave, electronic protection, antenna remoting, RF photonics, electro-optic modulator, high-speed optical modulator

N131-067 TITLE: Bio-fuel Reforming for High-Efficiency Solid Oxide Fuel Cell Generators

TECHNOLOGY AREAS: Ground/Sea Vehicles

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and demonstrate an innovative fuel reforming process, utilizing bio-fuel, scalable for a 10kW and greater solid oxide fuel cell system.

DESCRIPTION: Fuel cells offer a viable means to provide distributed ship service pier side as well as tactical electrical power. In tactical and shipboard applications there are benefits such as high efficiencies and lower heat/noise signatures compared to traditional generators. Also, fuel cells provide modular design options that dramatically improve the ease with which to perform general maintenance and to conform to a variety of platforms and applications. Compared to typical diesel generators, further benefits can be obtained through the use of fuel cells providing environmental benefits due to reduced NOx, soot, and greenhouse gas emissions. Beyond the basic benefits provided by fuel cell operation, the impact of using bio-fuel on these fuel cell systems, as compared to the use of existing Navy logistics fuel, include the potential to improve overall fuel cell system size, weight, efficiency, life cycle cost, and acquisition cost.

Bio-fuels are assumed to be similar to a paraffin-based fuel with no sulfur and negligible aromatic constituents. Paraffin fuels are easier to reform and require less energy to break the fuel bonds as compared to complex Navy distillate fuels. Because of this, the overall process efficiency of reformer and stack is expected to improve. This is due to the ability to operate the reformer at an optimum temperature and operating ratios, reduction of process parasitics, and the reduction of the potential to produce carbon deposition on the reformer catalyst material and increase overall catalyst life. In addition, operation with this fuel will theoretically enable reformer reactors to function at a wider operating range and still maintain complete fuel conversion. Finally, it enables the ability to operate with innovative fuel reforming processes which can operate as a stand-alone reformer or further integrate with the fuel cell stack in ways that were previously restricted due to the properties of logistic fuels such as JP8, JP5, and NATO F76.

It is desired to develop an innovative fuel reforming process which operates at high efficiency within a solid oxide fuel cell system to produce electric power from bio-fuel. The overall reforming process shall be thermally integrated to produce an effective package with minimal balance of plant components such as pipes, heat exchangers and valves. The unit shall also utilize simple control concepts to properly manage thermal balance during both start up, shut down, steady state, and transient operating conditions. Emphasis shall be placed on the design which reduces production cost goals of the power unit. The solid oxide fuel cell power unit concept shall be designed to achieve or exceed the following performance goals:

• System Efficiency: >40% based on LHV of bio-fuel
• Volumetric Density: 25 watts/liter
• Gravimetric Density: 20 watts/kg
• Stack Durability: >10,000 hours with less than 5% degradation
• Unit Power: 10 kWe, scalable to 100 kWe
• Airborne Noise: <70 dB
• Water Neutral

Proposals are encouraged to include a development plan and projected performance utilizing bio-fuel. Technologies with tested stack assemblies that have previously demonstrated the ability to operate within a power generation system are desired.

PHASE I: Develop a conceptual design of a fuel reformer for a Solid Oxide Fuel Cell (SOFC) power unit, operating on bio-fuel, and scalable in the range of 10–100 kWe per modular power unit. Emphasize system performance and complexity benefits by using bio-fuel. The 10 kWe conceptual SOFC power unit design shall include performance models for steady state operation and 3D layouts of the power unit. The concept shall include a basis for operation of the fuel reformer and power unit including startup, shutdown, load pickup, and reduction. A proof-of-concept of the notional reformer in a sub-scale demonstration would be beneficial.

PHASE II: Conduct a full scale development and demonstration test of the thermally integrated bio-fuel reforming process at a 10 kW level to demonstrate process benefits, operability, and controllability. Develop a detailed design for a complete 10 kW power unit incorporating the reformer previously developed. The power unit design should take advantage of the system benefits provided by the fuel characteristics. Refine the steady state process model and 3D conceptual layouts for both a 10 kWe tactical power unit and larger shipboard applications. Develop a dynamic model based upon the efforts of the Phase I concept, and the Phase II prototype design, that simulates the operability and transient performance of the fuel cell power unit. This reformer shall be demonstrated with a fuel cell, but does not require military environmental packaging.

PHASE III: Update the detailed design for a complete 10 kW power unit incorporating the reformer previously developed in Phase II. Build and demonstrate a unit for a tactical application including military packaging which demonstrates the technology advancements developed during Phase I and II. The unit will be delivered to a military facility for demonstration testing in a relevant environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology can be utilized for any commercial fuel cell application that uses biofuel as a source.

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KEYWORDS: Fuel Cells; bio-fuel

N131-068 TITLE: Materials Development of Periodically Oriented Gallium Nitride (PO-GaN)

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Electronics

OBJECTIVE: Develop growth of Gallium Nitride (GaN) wafers for periodically oriented, quasi-phase matched, nonlinear frequency conversion.

DESCRIPTION: Periodically Oriented Gallium Nitride (PO-GaN) has recently been developed for nonlinear frequency conversion of laser systems. PO-GaN offers a broader transparency range (0.39 - 6 µm) and better thermo-optic properties than any other nonlinear optical (NLO) material. Current laser technology is fundamentally limited by the useful transmission range of nonlinear optic materials. Nonlinear crystals such as BBO, KTP, and LiNbO3 have long been the standards from the ultraviolet (UV) to the near-infrared (IR) but their useful transparency range ends below 4µm. For longer wavelength sources NLO materials like ZGP, AgGaSe, and GaAs have been developed but these are incompatible with mature 1.0 and 1.5µm laser system. No current material will support conversion from UV to the mid-IR.

The potential for PO-GaN nonlinear optic devices is enabled by wafers grown on c-axis material with micron wide inversion domains between the gallium and nitride polarity. Currently, simultaneous growth of both polarities is a challenge that restricts overall thickness and quality. Growth of transparent high optical quality PO-GaN in thickness of several millimeters is desired for integration into advanced frequency agile laser systems. Goals for the PO-GaN growth would be for: low optical absorption and scattering (< 0.1 cm^-1), high-fidelity reproduction of pattern domains, and rapid growth of 1 millimeter thickness on centimeter scale wafers. Hydride vapor phase epitaxy (HVPE) has been demonstrated as a leading growth technique to deliver high growth rate epitaxial films needed to achieve millimeter thick films with acceptable optical quality.

PHASE I: Determine dependency of growth rate, defect generation, and impurity incorporation into periodically oriented growth of gallium nitride in a high growth rate process such as HVPE. Determine technical feasibility of dual-polarity c-axis gallium nitride growth. Develop approaches for balanced polarity growth rates leading to millimeter thickness of periodically oriented gallium nitride. Characterize materials properties to establish potential for utility in nonlinear optic devices.

PHASE II: Develop processes for extended millimeter growth of dual-polarity gallium nitride with low free carrier densities. Fabricate PO-GaN wafers with periodic polarity reversal for quasi-phase matched nonlinear frequency conversion. Then, conduct an evaluation of wafer optical quality and test nonlinear conversion of near-infrared laser system. Develop prototype PO-GaN devices for nonlinear conversion and quantify device efficiency and bandwidths.

PHASE III: Develop growth processes for commercializing PO-GaN wafer material for high power, broadband frequency conversion. Process improvements should target increase wafer diameter, growth rate, and compatibility with production process. Develop a partnership with the laser system integrator to make high quality PO-GaN material for DoD and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Broadband nonlinear optical devices enabling frequency conversion over the targeted range (0.39 - 6 µm) offer the potential for broad impact across several commercial applications. High interest applications include replacing the LiNbO3 devices in imaging devices, medical illumination, gas sensors and biochemical detectors.

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KEYWORDS: Gallium Nitride, Periodically Poled, Nonlinear Optics, Frequency Conversion

N131-069 TITLE: Electric Tail Rotor Drive

TECHNOLOGY AREAS: Air Platform, Electronics

OBJECTIVE: Develop and demonstrate an electric tail rotor drive for a helicopter.

DESCRIPTION: Recent years have seen significant advances in electric drive technology and increased interest in electrically-powered aircraft. It may now be possible to replace the mechanical tail rotor drivetrain in a helicopter with an all-electric system comprising a generator or generators driven by the main rotor gearbox, an electric motor at the tail rotor, and associated cabling and controllers. Potential advantages include reduced weight and maintenance, elimination of the intermediate gearbox (if any), simpler pylon folding, and electrodynamic braking to replace or augment mechanical rotor brakes. With the aircraft on the deck, an electrically driven tail rotor could be switched off entirely, providing an extra measure of safety to deck crew. Variable tail rotor speed could also be implemented with potential noise and performance improvements in forward flight. An electrically driven tail rotor could also be arranged to pivot in flight to provide forward thrust.

Electrically driven tail rotors are common in small-scale Commercial Off-The-Shelf (COTS) Radio Controlled (R/C) helicopters, where adequate electrical power is already available from batteries sized to drive the main rotor. Technical challenges in implementing an electrical tail rotor drive system for full-scale helicopters include efficient generation of adequate electrical power and scaling the system to a relevant size while maintaining favorable weight relative to the mechanical system it replaces. The motor controls must have sufficient authority and bandwidth to prevent tail rotor RPM droop following large pedal inputs.

This topic calls for the development and bench demonstration of an electric tail rotor drive system of size and operating parameters relevant to a naval helicopter selected by the proposer. The system should demonstrate technology for replacement of an existing mechanical drivetrain. Proposals should provide a credible review of relevant technologies and clearly outline sizing considerations underlying the selection of the subject helicopter.

PHASE I: Define and develop a concept for an electric tail rotor drive system. The electric tail rotor drive need not be designed specifically for a military aircraft, but must be of a size relevant to an existing naval helicopter, and with similar operating parameters. Primary system attributes are weight, efficiency, and maintenance relative to the corresponding mechanical drivetrain. While the concept should assume a conventional tail rotor of appropriate size and operating speed, advantages deriving from a replacement tail rotor optimized in combination with the electrical drive system should be identified. Tail rotor speed transients due to yaw and pedal input should be similar to those seen in a mechanical drivetrain. The system should be powered by electrical devices interfacing with existing drivetrain components. A conventional tail rotor gearbox may be retained; if not, the system should include components necessary to react to tail rotor loads into the supporting structure. System impact on vehicle Center of Gravity (CG) should be investigated. The final concept should be evaluated to the greatest extent possible through high-fidelity modeling and simulation.

PHASE II: Further develop and fabricate the electric tail rotor drive system defined in Phase I and demonstrate in a bench test. The demonstration should include the complete system and incorporate all drivetrain components between main rotor gearbox and tail rotor. In the bench test, gearbox-driven components may be driven by motors - an actual gearbox is not required. The tail rotor may be represented by an appropriate mechanical or aerodynamic load. No flight tests are contemplated in this Phase.

PHASE III: Refine the concept to a full-scale flightworthy system design incorporating all details required for a successful retrofit to an existing naval helicopter. Fabricate and demonstrate the system in a ground test at an appropriate facility.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: When operated in noise-sensitive urban environments, civilian rotorcraft may benefit significantly from noise reduction expected to accrue due to a variable speed tail rotor. Private-sector application may also include efficient distributed propulsion systems for large aircraft. The technology developed in this topic may help enable hybrid drive systems for aircraft and automobiles with improved efficiency.

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KEYWORDS: Rotorcraft; helicopter; tail rotor; electric motor; generator; drive shaft

N131-070 TITLE: Check Range Sensor Pod

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Provide the Navy submarine force the capability for a platform to check its signature condition when in a forward operating area by means of an autonomous reconfigurable sensor pod.

DESCRIPTION: Navy submarine and surface ship signatures are measured at land-based silencing facilities located around the Continental United States (CONUS) and occasionally at allied partner facilities [1]. However, the signatures can degrade over time for a variety of reasons, potentially making the platform more vulnerable to detection. ONR is seeking a disposable sensor pod to autonomously assess signature levels for in-situ tactical awareness that can be deployed from a submerged submarine utilizing existing platform capabilities.

The pod should be easily reconfigurable and be able to measure underwater magnetic, electric, and acoustic fields (or a subset of these). Each sensing modality should have sensitivity down to sea state 0 natural background noise levels, with a frequency range of 10-32 kHz for the acoustic subsystem and 0.001 – 3 kHz for the magnetic and electric subsystems [2],[3]. The pod should have the ability to accept and execute simple data processing algorithms, take measurements at a set depth down to 300 meters, transmit its position relative to the submarine within one meter, and send time-stamped data back to the platform for up to four hours in an underwater environment. The pod must be designed to self-scuttle by command or at end-of-life and ensure complete destruction of any data remaining on the pod. Multiple pods should be able to function simultaneously to enable the submarine to create a self-assembling measurement array in a forward operating area.

PHASE I: Define the concept for a novel compact signature-assessment pod that can be deployed from a submarine in diverse ocean conditions. Like a sonobouy, the pod should be low-cost so that it is expendable allowing the naval platforms to check on their signature condition in forward patrol areas away from CONUS measurement ranges. Clearly describe the procedure to deploy the pod and receive the data. Identify obstacles in design and establish solutions to demonstrate feasibility. Identify cost drivers in the design and adherence to safety concerns such as onboard stowage and boat-pod encounter. Identify the key critical hardware and software components and if possible show feasibility for one or more of these components in a laboratory demonstration.

PHASE II: Develop, demonstrate, and fabricate a prototype as identified in Phase I. Demonstrate the method of deployment with a non-functional mockup prototype. Construct several functional prototype pods that can demonstrate the Phase I performance goals for hardware and software by simultaneously performing measurements and relaying position relative to a signal source in a benign environment. Work with the Navy to create a test plan for at-sea validation of a notional signature-check range capability.

PHASE III: Conduct the at-sea validation of a notional signature-check range capability. Verify manufacturing affordability to meet a cost target for expendability and transition to commercial low-rate production for Navy and private sector applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Possible commercial applications of this technology include oceanographic environmental sensing devices, underwater intrusion detection systems (detection of swimmers and Unmanned Underwater Vehicles), and harbor protection systems (measurements of underwater hull condition and attached objects). Environmental assessment industry, gas and petroleum exploration industries using sea based platforms, and port/harbor/wharf security protection industries should find this technology to be of potential use for monitoring the water space around their structures, or for surveys.

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KEYWORDS: Underwater; sensor; magnetic; acoustic; electric; signature

N131-071 TITLE: Dense Core Ablative Nosetip Materials for Hypersonic Applications

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop and demonstrate high-density nosetip materials for advanced hypersonic projectile applications.

DESCRIPTION: The Navy is developing high-speed weapon systems for long-range surface fire support, missile intercept, and conventional prompt global strike applications. Hypersonic sea-level launch presents an extreme aerothermal environment with high heat flux, high thermal shock, and oxidizing conditions at temperatures >2500C. Current hypersonic nosetip materials are typically low-density ablators such as graphite, carbon-carbon (C/C), or Polymer Matrix Composites (PMCs) for re-entry vehicle and ballistic missile applications. For future Navy systems, a high-density nose tip will be needed to enable stable flight behavior of hypersonic sea-level projectiles. The nosetip will require a small nose radius to minimize drag, be of sufficient density in order to balance the center of gravity, handle extreme heat loads in highly oxidizing conditions, survive >30kG axial mechanical loads, >10kG transverse balloting loads, and thermal shock from surface temperature rise of 2000C/sec. However, it is believed that no single component material can meet the severe thermostructural and thermochemical design requirements of extremely high heat fluxes during the first seconds of flight, followed by longer flight at lower heat flux. With peak stagnation point heat fluxes on the order of 4500 BTU/ft2-s for a Mach 8 launch velocity(1) and densities over 15 g/cc, new materials solutions are sought, with multicomponent or functionally graded approaches likely necessary to minimize stress and handle oxidation issues. With a focus on high lift-to-drag ratio (L/D), hypersonic projectile testing in relevant environments will be necessary as the program progresses (as well as potential use in leading edge and rocket nozzle, combustor liner, and Thrust Vector Control applications)(2).

PHASE I: Assess legacy processing technologies and develop novel materials concepts for producing advanced nosetip materials. As the approach is developed, feasibility will be shown through proof of concept demonstrations. These demonstrations shall include quasistatic testing of materials systems with a focus on bonding/grading issues, as well as potential attachment solutions.

PHASE II: Optimize and scale up the materials approach formulated in Phase I. Prototype fabrication shall demonstrate the approach by producing relevant shape subscale parts, and then compare key performance data obtained from legacy and improved materials systems in severe thermal testing, such as arc-jet tests. There are potential ITAR and classification restrictions for technology when putting together materials concepts into relevant shaped subcomponent tests.

PHASE III: Apply the knowledge gained in Phase II to complete validation and certification testing. Develop a commercially viable process culminating in a prototype nosetip that can be integrated into a launch package or platform of interest. Then, conduct full-scale testing in relevant flight environments or other propulsion or extreme environment applications that has early ramp to transition. There are potential ITAR and classification restrictions for technology when putting together materials concepts into relevant shaped subcomponent tests.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Future military high speed and hypersonic propulsion components have a great potential to transition to the civilian rocket and related aeroengine applications such as low cost access to space. The materials resulting from these studies also have the potential for significant cost savings if they outperform existing state of the art materials systems. Further, these new materials may utilize revised fabrication methods which allow advanced component designs.

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KEYWORDS: Nosetips; leading edges; ablatives; projectiles; high heat flux; high temperature materials

N131-072 TITLE: Cost Reduction Technologies for High-Temperature Ceramic-Matrix Composite (CMC) Components

TECHNOLOGY AREAS: Air Platform, Materials/Processes

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Create and develop new CMC manufacturing approaches such as Field Assisted Sintering Technology (FAST) that offers flexibility, robustness, and reduces manufacturing costs of CMC components.

DESCRIPTION: Silicon carbide matrix reinforced with silicon carbide fibers (SiC-SiC) composite is a very attractive material due to high-temperature oxidation resistant properties, low density, and good creep properties needed for turbine applications. Significant progress has been made in the processing of
SiC-SiC composite. Over the past 10 to 15 years, significant investments have been directed towards the development and manufacturing of CMC components. Manufacturing costs for CMC components are still very high however with long lead times that must be reduced by 50% to enhance process viability. The requested research will conduct fundamental investigations of processes such as sintering to view phenomena of the CMC including interface between fiber, coating, and matrix under the concurrent application of high current density, pressure temperature, and time. Processing-structure-properties relationships will be established to allow complete exploitation of the benefits of this novel processing approach. Mechanical properties including tensile, flex strength, and creep will be examined at room and elevated temperatures.

The three processes for manufacturing CMC components have been: (a) Chemical Vapor Infiltration: a very slow process (100s of hours to densify preform), requiring tight parameter control that is not conducive to thick preform components, (b) Melt Infiltration: a comparatively fast process (few days), that lowers manufacturing cost, but is limited by liquid Si migration, and (c) Polymer Impregnation Pyrolysis: where pre-ceramic polymer precursors and multiple impregnations result in poor quality SiC matrix. The purpose of this SBIR topic is to develop a basic materials technology that would enable the production of more affordable 2700°F capable CMCs which could translate to a 2% decrease in fuel or a 2.1% increase in mission range for limited engine parts. Expanded CMC use would augment greater fuel efficiencies or mission range for military aircraft.

PHASE I: In the Phase I effort, conduct fundamental investigations of the phenomena of the CMC including interface between fiber, coating and matrix under the concurrent application of high current density, pressure temperature, and time. Processing-structure-properties relationships should be established to allow complete exploitation of the benefits of novel processing approaches. The proposed research should utilize an integrated, science-based framework to underpin and advance the development of integrally woven SiC CMC structures and should seek to identify and build a modeling framework to encompass manufacturing process simulation and quantitative processing-structure relationships, for assessment of process or product optimization.

PHASE II: In the Phase II effort, the investigators shall evaluate and validate the process models and acquire missing thermodynamic data if needed. The processing-structure-properties relationships will be validated to verify complete exploitation of the benefits of the novel processing approach. Mechanical properties (tensile, flex strength, and creep) should be characterized at room temperature and elevated temperatures. The effort should analyze the defects in tow architecture arising during various stages of manufacturability and matrix processing. It is desirable to be able to analyze strain and temperature distributions in textile composites with non-periodic architectures and asymmetric boundary conditions and develop a modular structure to accept mechanistic continuum damage models to describe matrix cracking, fiber fragmentation, and bundle rupture as well as other inelastic processes.

PHASE III: The investigators should connect with various original equipment manufacturers (OEMs) of aviation gas turbine components and materials to provide either support services for process optimization or license the process to allow the OEMs to exploit the benefits of this processing method for SiC CMC turbine components.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The major barrier to more extensive usage of SiC CMC components for gas turbine engines has been the cost of fabrication. Development of a most cost-effective manufacturing method for CMCs would lead to more extensive adoption and usage of CMCs components in both military and commercial aircraft that would lead to greater engine efficiencies and less fuel usage.

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KEYWORDS: Silicon carbide, SiC, ceramic matrix composites, CMC fabrication processes, ICME, sintering, chemical vapor infiltration, melt infiltration, polymer impregnation pyrolysis

N131-073 TITLE: Breakthrough Lightweight Transparent Armor Technologies

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop transparent armor materials or technologies that result in significant reductions in weight over the current state of the art.

DESCRIPTION: Transparent armors represent a substantial portion of the armor weight allocation for many ground vehicle platforms and usually weigh substantially more than opaque solutions designed for the same threat. In order to reduce weight and cost of armored vehicles, lighter-weight transparent armor solutions that maintain or improve on the ballistic performance of current generation solutions are required. Examples of current transparent armor technologies can be found in [1] and [2].

This program is seeking novel materials or technologies that can be incorporated into a transparent armor design that significantly reduces the weight over existing solutions. Since transparent armors are typically laminate solutions consisting of glass, polymers, and adhesive inter-layers, candidate technologies can address weight reduction by replacing or improving any of these components. Examples of technologies of interest include, but are not limited to, fiber-reinforced transparent composites, spaced arrangements, ultra-low defect strengthened glass technologies, improved bonding agents, and/or improved polymeric materials.

In addition to weight reduction, these technologies must take into consideration optical clarity, producibility, and durability. The end goal of this program is to incorporate the candidate technologies into an integrated transparent armor system for ballistic evaluation. Modeling and simulation are encouraged to guide the development of these technologies at either the component or system level.

PHASE I: Develop concept technologies to enable weight reductions of transparent armor while maintaining current levels of protection. Determine technical feasibility of concept technologies on a component level and propose an integration scheme for incorporation into a prototype transparent armor system. The desired protection level for a prototype system incorporating the concept technology is STANAG 4569 Level 3a [3]. Concept technologies should be developed to a Technology Readiness Level (TRL) 3 upon completion of Phase I. This would include mechanical testing, optical characterization, and producibility.

PHASE II: Construct and demonstrate an integrated prototype transparent armor system incorporating the concept technologies developed in Phase I. Conduct ballistic testing with relevant threats in accordance with ATPD 2352P [4] at a third-party, government-approved testing facility. Ballistic testing will ensure that reduced weight armor components maintain the level of protection typical of current state-of-the-art transparent armor solutions. Integrated prototype systems should be developed to a minimum of a TRL 5 upon completion of Phase II. Optimized design should undergo preliminary environmental testing as outlined in ATPD 2352. The goal for this testing is to determine any potential shortcoming for delamination, fracture, thermal stresses, and allow for optimization prior to Phase III durability testing.

PHASE III: Fabricate and install an integrated transparent armor system onto a USMC military tactical vehicle. Conduct durability testing over USMC operating profiles. Conduct full scale live-fire ballistic testing with representative fragmentation munitions and direct fire threats. Transition the technology to commercial military ground vehicle integrators and parts manufacturers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Lightweight transparent armor materials will have application to private and state vehicles which transport VIPs and state dignitaries. Lightening the weight of transparent armor will reduce wear and tear on these platforms in a similar manner as military tactical vehicles. In addition, lightweight transparent armor can be used for stationary applications for government and private structures to provide ballistic protection.

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4. ATPD 2352P, "Purchase Specification, Transparent Armor," Jul 2008.

KEYWORDS: Spinel, transparent armor, lightweight, materials, ballistic protection, armor

N131-074 TITLE: <u>Compact Laser System for Airborne Detection of Ocean Mines</u>

TECHNOLOGY AREAS: Sensors

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OBJECTIVE: Develop a compact and efficient multi-spectral laser system for active multi-spectral imaging (MSI) with four frequency bands across the visible and near infrared (NIR) for detecting surface and near-surface mines in the ocean.

DESCRIPTION: The detection of mines on the beach and floating/submerged mines in the ocean is accomplished with electro-optic (EO) sensors deployed on a Tactical Unmanned Airborne Vehicle (TUAV). Complex issues include target contrast with the background and false detections. The objective is to develop a compact, efficient multi-spectral laser with four frequency bands across the visible and near infrared (NIR). At least two bands should span across both sides of the NIR vegetation rise and at least one should provide in-water illumination. The water depth is 20 feet. Pulse widths of less than 4 nanoseconds are required for range-gated operations with imagers. Sufficient pulse power (500 mJ for in-water illumination and 150 mJ for other bands) is needed for large area imaging. The repetition rate is greater than 50 Hz. The Size, Weight, and Power available in the TUAV for the laser are 1 cubic foot, 80 pounds, and 1.0 KW at 28 volts DC power.

PHASE I: Define and develop a concept for a compact, efficient multispectral laser system that can meet the performance and the SWaP constraints listed in the description. Perform modeling and simulation to provide initial assessment of concept performance. Phase I Option would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Development of a prototype based on Phase I work for demonstration and validation. The prototype should be delivered at the end of Phase II, ready to be flown by the government.

PHASE III: Integrate the Phase II developed multi-spectral laser prototype with an imager, flight test the complete system, and integrate into the SHD-12-04 FNC program for transition to the ALMDS and/or COBRA acquisition programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Marine Survey, Bathymetry, Search & Rescue

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KEYWORDS: Compact Multi-Spectral Laser; Detection of Ocean Mines; TUAV Sensor; Drifting Mines; Airborne Mine Detection; Submerged Mines

N131-075 TITLE: Automated Generation/Learning of Discrete Event Simulation Models

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

OBJECTIVE: To develop machine learning and automated model generation methods to understand the flow of traffic (aircraft, people, and equipment) on carrier decks and related chaotic and constrained environments. The focus of this effort will be to develop methods that can utilize data from RFID tags, inexpensive cameras, and other inexpensive passive sensors to generate testable and scalable discrete event models of behavior from observation. Note that the focus of this effort is not on the development of new sensing hardware, sensor processing, or computer vision or tracking algorithms. Rather the solution should consider how the existing state-of-the-art in these areas could be used to generate data for the machine learning/model generation methods to model activity on the deck.

DESCRIPTION: Aircraft handling aboard the flight and hangar decks of aircraft carriers is a series of complex processes in a constrained and chaotic environment. This includes recovery, refueling, payload loading, servicing and maintenance, manning, and positioning for the next launch. Understanding the flow of aircraft, people, and equipment through these processes is a challenge given the space constraints, available parking areas which change depending on the phase of ship operations, weather, operational factors, and constraints on people and equipment. As unmanned air systems begin to integrate in greater numbers it will be critical to understand this traffic flow better to allow for the development of wholly new paradigms that can optimize the use of both manned and unmanned systems, and support the increased tempo of operations and higher sortie generation rate requirements of future carriers. The focus of this effort will be to develop methods based on machine learning and automated model generation that can utilize data from RFID tags, inexpensive cameras, and other inexpensive passive sensors to generate testable and scalable discrete event models of behavior from observation. While work has been done with model generation in limited and relatively static domains, there are significant challenges in machine learning/automated model generation with large numbers of physical agents in an efficient and scalable manner and in such a complex environment. Advances have been made and demonstrated within simpler domains such as team sports with a limited number of players, collective animal behaviors, and logistics and inventory applications. While solving the general automated modeling problem with such a large number of moving entities would probably not yet be feasible, carrier operations have a structure that can be exploited to make this problem potentially feasible to solve.

One significant challenge will be utilizing the type of data that is available from passive sensors. For example, interrogating passive RFID tags can be useful for identification and status information, but may have significant limitations in the precision of localization. As well, interrogation will be constrained by shipboard RF limitations. In contrast, vision systems may provide much greater localization precision and longer term tracking, but may have difficulties dealing with large and variable numbers of entities of interest, synchronizing multiple sensors, maintaining tracks in cluttered and occluded environments, and detecting relevant entities in the environment while avoiding non-relevant ones.

Also, note that equipment refers only to mobile heavy equipment that impacts traffic flow on the decks (e.g., forklifts) and not tools and parts inventories. Tracking of smaller items that do not have significant impact on traffic flow is outside the scope of this topic.

PHASE I: Propose a sensing method that would be appropriate for the environment of a carrier. Develop and implement an initial version of the proposed model generation/learning methods for a limited set of ship-like environmental factors with sufficient functionality to demonstrate feasibility. This could leverage data from simulations, pre-recorded data from activity in a constrained environment (with similarity to the carrier deck case with regards to particular characteristics), and/or very limited scope laboratory experiments with sensor hardware. Note that the use of actual data or data collection from an actual carrier is not required. A similarly constrained environment in a laboratory or outdoor environment with moving people and equipment would be sufficient. Develop metrics to evaluate the system in Phase II and determine an initial concept for how the approach could be used in a carrier environment.

PHASE II: Further develop the proposed learning/model generation approach with a broader set of environmental conditions in a more dynamic and unstructured environment that has much of the complexity of a carrier environment. Then integrate these with a higher fidelity simulation and experiments with live assets in a laboratory environment. Refine the proposed sensing methods. Similar to Phase I, the use of data, or data collection, from an actual carrier is not required. A similarly constrained environment with moving people and equipment would be sufficient to test the feasibility of the approach. And, refine how the approach could be used in a carrier environment.

PHASE III: Integrate the software with other components in a naval system and participate in integrated demonstrations of autonomous systems operations or in experiments with manned assets on a carrier deck.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability could be used in a broad range of military and civilian security applications of unmanned systems and in other applications involving management of automated systems, such as logistics, inventory, and industrial applications.

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KEYWORDS: Carrier operations, machine learning, automated model generation, passive sensing

N131-076 TITLE: Advanced Adaptive Optics (AO) for Laser Weapons in Heavy Turbulence

TECHNOLOGY AREAS: Sensors, Weapons

OBJECTIVE: Develop a beaconless adaptive optic system capable of correcting moderate to heavy atmospheric distortion of the high-power laser beam in laser weapon systems.

DESCRIPTION: Adaptive Optics (AO) are used routinely in astronomical telescopes for correction of atmospheric distortion. More recently, adaptive optics have been implemented on laser weapon systems including the Airborne Laser. However, both of these applications require a reference source for measurement of the atmospheric distortion. In the case of astronomical telescopes this can be either a natural or artificial star. For the Airborne Laser a beacon illuminator laser was used. This beacon laser complicates the optical path and adds cost and complexity to the system.

For future laser weapon systems we seek to develop a beaconless adaptive optic system capable of correcting moderate to heavy atmospheric distortion of the high power laser beam. There are most likely several possible approaches to this solution. One possible approach may be to utilize the High-Energy Laser (HEL) as a source to extract information from the target image which can be used to provide beam control corrections. Other possible optical techniques may utilize characterization of the laser beam distortion or statistics of the atmospheric turbulence. If you were to use the HEL technology in your approach, challenges will include avoidance of stray light from the HEL and speed of response of the AO system as well as aberration measurement and compensation. The proposed system should demonstrate near diffraction target imagery for targeting in deep turbulence conditions (Rytov >.3), wavefront aberration determination to a tenth wave at 1 micron, and wavefront correction through the AO system to a tenth wave.

PHASE I: Develop theoretical analysis and design of the system modeling and simulation indicating beaconless imaging, aberration metrology, and level of compensation achieved. The proof-of-concept prototype system should obtain as a goal a tenth wave aberration measurement and compensation ability in a Rytov >.3 turbulence condition.

PHASE II: Prepare and test the prototype in a laboratory and verify level of performance. The system should obtain as a goal a tenth wave aberration measurement and compensation ability in a Rytov >.3 turbulence condition.

PHASE III: Demonstrate developmental system with field testing and performance verification.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This SBIR topic will have applications to all imaging and telescope systems such as astronomy, space surveillance, Light Detection and Ranging (LIDAR), and communications which are limited in resolution by atmospheric turbulence. These systems can benefit from a beaconless guide star and atmospheric compensation technology.

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KEYWORDS: Laser beacon; guide star; high-energy laser; adaptive optics; atmospheric turbulence compensation

N131-077 TITLE: Motion-induced Human Performance Degradation Assessment

TECHNOLOGY AREAS: Ground/Sea Vehicles, Biomedical, Human Systems

OBJECTIVE: Develop methods, metrics, and technologies to assess the impact of motion-induced interruptions and motion-based mediating variables such as sopite syndrome and motion sickness on human performance.

DESCRIPTION: Warfighters are exposed to a multitude of motions resulting from weather and sea conditions. Ship motion directly impacts human performance via motion-induced interruptions (MIIs) as well as through mediating variables such as motion sickness and sopite syndrome. There are large individual differences in motion sickness susceptibility (Kennedy, Dunlap, and Fowlkes, 1990). Motion sickness symptoms include stomach awareness, malaise, cold sweating, pallor, nausea, and emesis (McCauley et al., 1976). In some individuals motion sickness may impact their ability to complete essential tasks. Ship motions may also disturb the balance of crew members, increase the energy expenditure of individuals working on board, and often result in increased levels of fatigue and drowsiness (Stevens and Parsons, 2002). Additionally, sopite syndrome presents a unique motion-related sickness profile that may also impact performance. Sopite syndrome relates symptoms of fatigue, drowsiness, and mood changes to prolonged periods of motion and has been attributed to motion-induced drowsiness (Gaybriel and Knepton, 1976).

Methods, metrics, and technologies are needed to support the assessment of MIIs and the impact of mediating variables on human performance within operational environments. MIIs have traditionally been thought of as interruptions in gross motor movements and control, such as balance, and have been categorized as trips, slips, and falls (or compensatory actions to prevent these errors). Motion-related performance interruptions, however, may also include errors such as pressing the wrong button on a touch screen. Therefore, consideration must also be given to fine motor movements and manual dexterity with relation to ship motion.

Validated paper-based assessment tools exist for assessing some aspects of motion-induced human performance degradation such as motion sickness. Limitations of this approach include cumbersome and time consuming data collection and analysis processes. To address these limitations, a comprehensive technology-based tool set is necessary to provide real-time and longitudinal assessments within operational environments.

PHASE I: Develop the framework for methods, metrics, and technology tools to assess and predict human performance degradation resulting from MIIs, sopite syndrome, and motion sickness. The components in the framework should build on and extend current state-of-the-art capabilities. Proposed data collection and analysis technologies should be unobtrusive and capable of collecting multiple sources of data simultaneously and synchronizing that data.

PHASE II: Develop a prototype suite of tools based on the framework established in Phase I. Conduct an initial validation of the tools through empirical evaluations with a targeted naval user community within a relevant environment.

PHASE III: Produce and market the suite of data collection tools for integration with ship and submarine test and evaluation programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The suite of tools (methods, metrics, and technologies) will have widespread applications to military, government, and private sector organizations in which it is important to assess the impact of motion-induced interruptions and motion-based mediating variables on human performance.

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KEYWORDS: Sopite Syndrome, Motion Sickness, Motion Induced Interruptions, Human Performance

N131-078 TITLE: Next Generation Electronic Support Measures Trainer for Submarines

TECHNOLOGY AREAS: Information Systems, Electronics, Human Systems

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a game-based adaptive training prototype for the submarine AN/BLQ-10 ESM operator to include realistic training scenarios presented on an animated and interactive AN/BLQ-10 workstation with adaptive feedback to the operator.

DESCRIPTION: The decision-making process in the Undersea Domain has become flooded with information processing at all stages, from sensor data through digital archives to analysis. Undersea warfare has global dimensions where military actions taken at each stage can have wide implications and require rapid, comprehensive, and sound interpretation of large volumes of sensor data to succeed. Without enabling tools, risks such as mistaken identity or association can be costly. The ability to manage and leverage escalating volumes of sensor data is fundamentally important for effective operations and has the potential to help undersea warfighters with situational awareness and provide rapid support to operations. Of primary concern is the ability of submarine crews to manage increasingly complex sensor data in the electronic domain in Anti-Access Area Denial environments. There is a need to improve our ability to incorporate this data into shipboard and submarine tactical decision-making from the sensor level (improved electronic sensor planning) to shipboard tactical level (incorporation of electronic sensor plans into overall ship and submarine planning.) Additionally, the Undersea Enterprise is concerned with the ability of the Integrated Undersea Surveillance System (IUSS) to manage large volumes of sensor data. In the mid-70s, the IUSS community operated twenty-two facilities and employed over 3500 personnel to detect, classify, and provide timely reporting of information on submarines and other contacts of interest. Today, modern technology has both increased the detection capabilities of ocean sensors while consolidating the number of ocean processing facilities. Today, the Undersea Enterprise operates two ocean processing facilities with approximately 1000 personnel creating a classic sensor information overload problem. The requirement to make good decisions and control risk in undersea operations demands the development of tools to manage sensor overload in both the electronic and IUSS domains.

State-of-the-art AN/BLQ-10 [1] training devices are expensive, unreliable, and provide radio frequency emission output only. The training scenarios are inflexible, require the student to progress from easy to hard lessons with minimal feedback, and the AN/BLQ-10 training interface does not match the actual system. This training deficiency results in EW operators lack of declarative (knowing "that") and procedural (knowing "how") knowledge in operating the AN/BLQ-10 system which negatively impacts the submarine command team’s decision making processes. By developing game-based training software and adaptive learning algorithm techniques, a new interactive AN/BLQ-10 training capability may meet submarine EW fleet requirements. The Next Generation Digital ESM Adaptive Trainer for the submarine EW operator should be embedded in the Next Generation Submarine EW system. The Next Generation Submarine EW system will digitize the radio frequency (RF) spectrum, providing digital data sets (i.e., Emitter Tracks, Pulse Descriptor Words, Continuous Digital Intermediate Frequency and Burst Digital Intermediate Frequency) in real time to the AN/BLQ-10 processing layer and output will be distributed to the controls, displays, and workstation for operator interaction. Required are All-World Environment Electronic Domain models and mapping from authoritarian ESM sources (e.g., electromagnetic) that support realistic planning, course of action analysis, and training. The Next Generation Digital ESM Adaptive Trainer must create gaming scenarios that establish and maintain kinematics of the gaming environment and provide input to the individual subsystem processing algorithms to allow the electronic operator sitting at the AN/BLQ-10 workstation to manipulate the generated environment as he would if he was receiving RF from the environment. The eventual training system must be modular and easily extensible to allow for future growth as the AN/BLQ-10 adds or improves functionality and data sources.

The training system must generate multiple training scenarios and support up to 2048 simultaneous digital emitter streams. The training system must generate Integrated Broadcast Service data feed simulations that are time coincident with the rest of the operational scenario. The EW training system must provide Submarine Warfare Federated Tactical Systems/Tactical Local Area Network (TACLAN) contacts to the EW system and are time coincident with the operational scenario. The Next Generation Digital ESM Adaptive Trainer will allow the operator to interact with the simulation data as well as archive data, such as emitter databases - leveraging the processing applications and data store capability resident in the AN/BLQ-10 without building simulated applications needing to be refreshed when the AN/BLQ-10 is updated. The Next Generation Digital ESM Adaptive Trainer must be limited to 12U of physical frontal footprint in a standard 19 inch rack and consume no more than 8000 watts of energy while in operation. The Next Generation Digital ESM Adaptive Trainer must operate in multiple classifications from UNCLASSIFIED to TOP SECRET SCI.

PHASE I: The small business will determine the technical feasibility of a Next Generation Digital ESM Game-Based Adaptive Trainer for submarine ESM operators. The small business shall (1) define and develop an ashore-based hardware and software architecture trainer concept that would connect to the submarine TACLAN simulator and AN/BLQ-10 system, (2) define and develop an afloat-based hardware and software architecture trainer concept that would connect to the submarine TACLAN and Virginia Class submarine Onboard Team Trainer master controller that interfaces with the Digital EW Trainer, (3) define and develop an adaptive training approach to measure operator performance and provide trainee and trainer feedback, and (4) produce a conceptual design of an Adaptive Trainer concept and model key components such as AN/BLQ-10 interface display, operator performance, and feedback.

PHASE II: Using results from Phase I construct and validate the prototype for the operation of a Next Generation Digital ESM Game-Based Adaptive Trainer for submarine ESM operator. The operator interface will link to the actual AN/BLQ-10 workstation and supporting software. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Develop and demonstrate automatic human performance data collection that passively collects ESM operator input while sitting at an AN/BLQ-10 workstation. Develop, demonstrate, and field test a game-based adaptive training prototype that links the AN/BLQ-10 workstation, submarine TACLAN, and operator decisions. The field test data collection should demonstrate that operators using the Adaptive Trainer prototype achieved greater skill levels than operators using the traditional AN/BLQ-10 training system.

PHASE III: If Phase II is successful, the company will support NAVSEA 07TR (Undersea Warfare Training) and PMS-435 (Submarine Imaging and Electronic Warfare Systems) in transitioning the technology for Navy use. The company will develop a Next Generation Digital ESM Trainer for submarines for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Government commercialization should be applicable across all EW training platforms in the Navy. Commercial applicability could be utilized in the telecommunications industry and in information technology architecture training to name a few.

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KEYWORDS: Adaptive Training; Electronic Support Measures; Gamed Based Training; Electronic Warfare; Submarine

N131-079 TITLE: Compact Off-board Passive Target-Discriminator

TECHNOLOGY AREAS: Sensors, Battlespace, Weapons

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: Develop a concept that utilizes one or more passive compact off-board sensor(s) to rapidly discriminate multiple maritime targets in a high contact density environment. Develop low-power multi-modal data fusion methodology, as required, based on limited data from this and other potentially available compact sensors.

DESCRIPTION: The sea battlespace presents a complex environment for clandestine surveillance and identification of multiple surface, sub-surface, and air targets traveling close together and for communications between sensor nodes. Data sharing and wireless network architectures must be efficient and functional with minimal data transmissions (<1kb) per decision to conserve power, maintain stealth, and enable rapid responses. Mission durations may reach one year, therefore, distributed sensing systems require methods and design tools for extracting maximum value from minimal passive information. The ability to quickly extract information on target type, position, heading, and speed is needed to ensure high probability of successful and timely responses. Tools and methodologies should present single point and summed single point data interpretation methods with an emphasis on low data rates and amounts looking for (but not limited to) target type, bearing, azimuth, and range. Operational methods for data collection and analysis should be compatible with very small (< ½ the volume of an A-size sonobuoy) and ultra-low power (i.e., passive) sensor nodes.

PHASE I: Phase I will generate an operational concept and one, to a few, preliminary hardware designs capable of recording, processing, and sharing data in a wireless manner with other sensors and a remote operator. The method of wireless communication will be determined as needed with the developer and the sponsor. The preliminary hardware design(s) will be given the opportunity to vet, via modeling/simulation, against target signature data from currently available sources prior to final sensor modality selection and for pre-selection laboratory test and evaluation. The deliverables of Phase I will include a preliminary hardware design documentation and related software (up to and including) detailed instructions on firmware setting(s) along with drawings and methodology documentation.

PHASE II: During Phase II, the breadboard sensor(s) and data processing methodology developed during Phase I will be converted into prototypes to collect data against targets of opportunity, prior to an at-sea experiment of the prototype sensor against said targets of interest. The prototype sensor will be expected to discriminate said targets of interest from at least one relative class of targets under the same environmental conditions. The deliverables of Phase II will include all hardware, software (to include detailed instructions on firmware settings) and detailed drawing and design packages for prototypes, and the test results from the at-sea experiment.

PHASE III: During Phase III, the sensor(s) tested during Phase II will be configured into a production-level package and optimally programmed against a high-value target. The sensor(s) will be expected to operationally discriminate said high-value target from at least three relative classes of targets known to present similar signature profiles under the same environmental conditions. The deliverables of Phase III will include all hardware, software (to include detailed instructions on firmware settings) and detailed drawing and design packages for the prototypes, and an assessment the concept's operational utility.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability for ports and waterways to be monitored for ship traffic; the ability for long duration at-sea, monitoring of whale and fish traffic; long-term standoff seismic monitoring at sea.

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KEYWORDS: Distributed sensors; target discrimination; vessel intent

N131-080 TITLE: Frequency Agile Millimeter Wave (MMW) Signal Generator

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop innovative technology and techniques to enable a frequency-agile MMW signal generator tunable for high performance military and commercial applications from 30 GHz to 120 GHz and with a path to extend the range to 300 GHz.

DESCRIPTION: The short wavelengths associated with MMW frequencies enable high baseband throughput and very high antenna gain with relatively small antennas. This enables high speed, high directivity portable links and sensors for applications ranging from covert short to mid-range communications to high resolution imaging, scanning and targeting. Future portable/mobile military MMW equipment may have to become multifunctional and be able to utilize frequency bands in an agile, flexible manner. This can be important in many military systems where frequency agility provides significant system performance advantages due possibly to growing network congestion, or more likely to enable agile switching between applications optimized in diverse frequency bands.

For example, the large range of atmospheric attenuation over the millimeter wave bands allows a user to flip between higher attenuation short range covert applications, or lower attenuation longer range applications like rapid deployment of high speed access links. Also, more widespread application of cognitive radio techniques has frequency agility as a prerequisite. Beyond communications, rapidly tunable low phase noise MMW oscillators and signal generators have active/passive sensor front-end utility in dynamic, re-configurable wideband signal generation and reception. This forward-looking electronics hardware effort develops techniques for small footprint portable MMW transceivers that will enable broad and continuous tunability over the frequency range of 30 - 120 GHz with a path to extend the range to 300 GHz. In addition to wide frequency tunability, successful electronic and/or photonic approaches shall support low phase noise and fast tuning capabilities and produce moderate output power at reasonable efficiency.

For the purpose of this SBIR topic, frequency-agile MMW communications should be highlighted and used to focus on the signal generator design, development, and demonstration. Terrestrial transmission distances targeted for the low attenuation bands should be 1 - 5 km with a path to achieving 10 km and beyond. Accordingly, the net MMW transmit power should be >+10 dBm with a path to >+30 dBm, where antenna gains of approximately 50 dBi are assumed to be available, and data rates up to 10 Gbps are targeted. A prototype of this tunable MMW signal generator will be built and demonstrated.

State of the Art: Existing commercial MMW implementations use small form factor, mid-power MMW generators based on solid-state IMPATT and/or GUNN diodes in high precision resonant cavities, and more recently high quality radio frequency (RF) Monolithic Microwave Integrated Circuits (MMIC) based on Si, SiGe, GaAs, InP and GaN. While high carrier frequency operation and reasonable output power of these devices are possible, they typically operate in a narrow band mode and have not demonstrated the wide tunability required for this SBIR topic. These limitations are not primarily due to the devices themselves, but due to the complex high gain/high power electrical amplifier circuitry and frequency generation circuitry that is required for these purposes which imposes severe limits on broadband operation. For this reason, current MMW signal generation devices are typically centered in well used bands like 60 GHz, 72 GHz and 94 GHz. The next planned bands include 120 GHz and 220 GHz. If broadband tuning is required, the only solutions available today involve combing multiple sources optimized for specific frequencies.

PHASE I: Define and develop a design for a widely tunable 30-120 GHz signal generator that can be used as a source for high quality tunable MMW signals. This phase will specify the signal generator requirements and specifications based on available high gain antenna structures and highlighted MMW wireless communications application.

PHASE II: Implement the detailed design of the key components of the tunable MMW signal generator specified in Phase I. A concept demonstration using a low phase noise, single frequency prototype of this signal generator will be built to demonstrate 30-120 GHz tunability at targeted power levels. A path to 300 GHz frequency operation shall be developed.

PHASE III: A low size, weight, and power (SWAP) frequency agile signal generator prototype will be developed, tested, and evaluated with a baseline 10 Gbps modulation signal applied for demonstration purposes. A total output of power in excess of +20 dBm in the sidebands over the entire range of 30-120 GHz will be demonstrated. Single frequency source tunability to 300 GHz will be demonstrated.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial sector is very interested in high-capacity short to mid-range wireless communications for voice, video, and data services. For increased capacity and less network congestion, these wireless applications continue to migrate to higher operating frequencies as affordable electronics technology becomes available. This technology will add to the toolkit of electronics transceiver hardware suitable to cover the full MMW spectral region of interest to commercial wireless system designers.

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KEYWORDS: Millimeter Wave; Communication Links; Wireless Communications; Tunable Sources; Oscillators; Signal Generation

N131-081 TITLE: <u>Membrane-Based Deformable Mirrors for High Power Laser Systems</u>

TECHNOLOGY AREAS: Space Platforms, Weapons

OBJECTIVE: Develop MicroElectroMechanical Systems (MEMS) or larger scale membrane-based deformable mirrors for use with high power lasers and directed energy weapons.

DESCRIPTION: Deep turbulence conditions will exist in many Navy scenarios where the propagating high energy beam will expedite both phase and scintillation corruption. Scintillation becomes a significant problem in deep turbulence regimes where the atmospheric path has a Rytov number that exceeds 0.3, but is especially bad beyond 1.0. Current deformable mirrors for use with high power lasers utilize relatively thick continuous faceplate mirrors driven by piezoelectric or electro-ceramic actuators. The systems are expensive, bulky, and provide a relatively low number of actuators which restricts the number of modes that can be corrected. A large number of actuators with high bandwidth are needed in deep turbulence. MEMS, or other membrane-based deformable mirrors, have demonstrated low cost, high actuator count deformable mirrors.

The Navy is seeking AO systems which adapt the membrane-based technology to deformable mirrors for high power lasers. The beam control optics should be capable of handling intensity levels of up to 40 kW/cm2 and total laser power exceeding 100 kW for at least 30 seconds. The AO should be able to be addressed at high speed with low latency to compensate for aberrations moving due to high wind velocities, or platform or target motion. Because deep turbulence can have high D/r¬0 ratios (where D is the aperture diameter and r0 is the Fried coherence diameter), beam control optics with high actuator density and larger number of actuators are of interest.

Desired Features:
• Capable of producing a one-wave phase discontinuity with minimal optical loss.
• Achromatic and not dependent on polarization.
• Capable of being addressed at speeds in excess of 10 kHz at phase change rates of 20 nm/μs or greater.
• Higher-order beam control optics with large actuator counts (>1000) and high actuator densities (actuator spacing <3 mm) ideally with a path to low cost manufacturing and parallelizable manufacturing.

Required Features:
• When designed to be used in the full high-energy laser beam, laser power handling of >100 kW with ?/20 uncompensated distortion over 30 seconds of high power illumination and less than 15% of the actuator stroke used to compensate thermally induced distortion.
• Capable of handling laser irradiance levels of >40 kW/cm2.
• To facilitate the use of pulsed illuminators, phase modulator should be able to handle peak pulse power >1 GW over the aperture diameter.

Beam control, in the presence of deep turbulence, has typically been addressed with a conventional AO system consisting of a wavefront sensor and a deformable mirror or liquid crystal phase compensator but suffer performance limitations due to atmospheric induced phase and amplitude aberrations. Analysis and demonstration of alternative architectures and comparison against a standard AO architecture is of interest, particularly systems that can feasibly operate in real time with current or near-term technology.

PHASE I: Develop a design of a membrane-based Deformable Mirror system including analysis, modeling, and simulation of system performance addressing the above desired and required features.

PHASE II: Develop a demonstration mirror capable of handling 10 kW/cm and 20 kw total of laser power at 1.06-1.07 micron wavelength. Verify performance against the above desired and required features. Develop an analysis and design of an advanced AO system with phase and amplitude compensation control.

PHASE III: Demonstrate an AO mirror for a 40kW /cm and 100 kW laser system addressing above desired and required features. Demonstrate an advanced phase and amplitude AO control system in the lab.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An AO system capable of handling high laser power would be of interest to wielding community. Deep turbulence correction for laser propagation is of interest in a large number of communication and laser sensing applications including astronomy, space situation awareness, and Light Detection and Ranging (LIDAR).

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KEYWORDS: Adaptive optic system; deformable mirror; high energy laser; deep turbulence; Micro Electro Mechanical Systems

N131-082 TITLE: Unmanned Aerial System Operator Selection Tools

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop an Unmanned Aerial System (UAS) operator test selection battery integrated into the Department of the Navy’s (DoN) existing Automated Pilot Exam (APEX) framework.

DESCRIPTION: Beginning in FY12, the DoN will significantly increase its acquisition of a wide range of UAS. Despite advances in UAS capabilities, over 50% of all UAS mishaps are attributed to human factor issues, beginning with poorly defined UAS operator selection capabilities. Effective selection procedures identify individuals who possess a minimum level of qualifications and the aptitude to acquire the relevant knowledge, skills, and abilities to perform specific tasks and missions. Done properly, selection and classification procedures reduce attrition rates from training, reduce costs associated with developing user interfaces, and improve operational performance.

There are currently no tools in place to select and classify candidate UAS operators based on these competencies. Preliminary research suggests that such tools should include an emphasis on assessing: spatial capabilities [1]; social and interpersonal abilities and personality traits [2,3]; executive processes, like attention management, information processing, multitasking and decision making [4,1]; and human–autonomy interactions [5,4]. Additional capabilities, with associated assessment tools, may also factor into developing an overall UAS air vehicle operator (AVO) selection capability.

This topic requests technologies for selecting individuals with the aptitude to acquire the relevant knowledge, skills, and abilities to perform UAS specific tasks and missions across different platforms. Importantly, the resultant technologies should be compatible with the DoN secure web-based test delivery platform, APEX. APEX is currently used to deliver the manned Aviation Selection Test Battery worldwide. Specific products from this topic include:
1) An ontological representation of the knowledge, skills, and abilities relating to operating DoN UAS platforms according to platform and mission.
2) UAS operator selection tests and development of data collection instruments to capture test measures.
3) The ability to extend to new platforms and missions.
4) The ability to include additional positions. (Main focus is on the UAS position known as the Air Vehicle Operator (AVO) but tool should be extensible to other positions such as the Mission Payload Operator.)

PHASE I: Prepare a feasibility study for developing a technology that will support the effective selection of UAS AVO. The performer will propose a prototype system and a preliminary design/architecture to include descriptions of: proposed measures; appropriate testing methodologies and technologies; and, metrics and plans for validating the resultant selection technology. A final report will be generated to include system performance metrics and plans for Phase II. Phase I should also include the processing and submission of all required human subjects use protocols.

PHASE II: Phase II plans should include key component technological milestones and plans for at least one operational test and evaluation. Develop prototype system based on the preliminary design from Phase I. All appropriate testing will be performed, and a critical design review will be performed to finalize the design. Phase II deliverables will include: (1) a working prototype of the technology; (2) specifications for its development; and, (3) test data on its performance collected in one or more operational settings.

PHASE III: Deploy the developed system for use in the selection of UAS operators for at least one planned DoN UAS platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This selection technology will have broad applications in military as well as commercial settings. UAS operations are projected to continue to grow over the next decade in military, federal, and local law enforcement applications. The ability to quickly and effectively identify those individuals with the appropriate knowledge, skills, and abilities will ensure that across these different sectors, UAS operations are conducted safely and cost effectively.

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KEYWORDS: Unmanned Aerial System; Selection Test; Knowledge, Skills and Abilities; Aviation Selection Test Battery; Ontology

N131-083 TITLE: Multiple Spectral Band Laser

TECHNOLOGY AREAS: Sensors

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OBJECTIVE: Develop a compact, rugged, and multiple spectral band laser for target illumination and detection, meeting specified Nominal Ocular Hazard Distance and intensity requirements.

DESCRIPTION: Some military platforms require a laser diode based and small size, weight, and power (SWaP) multi-color laser for a variety of applications. While lasers with similar capabilities are commercially available, none can meet all of the following requirements:

1) Output beams with wavelengths at ~640 nm, ~830 nm, and ~1700 to be parallel within 50 micro-radians of azimuth, elevation and roll, and to not be separated more than 5 mm in azimuth.
2) Beam output divergence to be 2 mrads x 174 mrads with a beam profile of Gaussian in the Azimuth (2 mrads) and uniform in the Elevation (174 mrads).
3) A minimum of 2.0 watt peak power and maximum of 8.0 watts at each wavelength.
4) Pulse rise and fall times to be 1-2 microseconds for up to 10 kHz pulse modulation following an external synch signal.
5) Beam axes separation from laser outer mechanical housing no more than 10 mm from the module top or bottom.
6) Laser to provide laser temperature output.
7) Beam direction adjustable in elevation, azimuth, and roll to an accuracy of 0.1 mrad.
8) Wavelength stability with ambient thermal state variation from -40C to +70C.
9) Compact package for embedding into larger system optical heads. Laser module(s) includes laser head, thermal controller (if used), and modulated driver.

PHASE I: Prepare a design and build a breadboard that demonstrates significant progress (i.e. greater than 75% of some or all criteria) toward Navy optical output requirements listed above. Model projection optical design in Zemax. Measure M^2 along with all beam parameters required for laser hazard analysis. For Phase I report, vendor should submit lab measurement data to support Phase I breadboard performance, Zemax file, mechanical designs in IronCAD compatible format, electronic circuit diagram schematics, and detailed technical path forward to achieving 100% of Navy optical output requirements listed above.

PHASE II: Construct breadboard demonstrating 100% of Navy optical output requirements listed above. If projection optical design changed from Phase I breadboard design, model in Zemax. Measure M^2 along with all beam parameters required for laser hazard analysis. Provide breadboard hardware to Navy for evaluation/validation as an interim deliverable along with lab measurement data to support Phase II breadboard performance, Zemax file (if needed), mechanical designs in IronCAD compatible format, and electronic circuit diagram schematics. Construct four demonstrator units addressing initial packaging approach and deliver to Navy for testing as a final Phase II hardware deliverable. For Phase II final report, vendor should submit lab measurement data to support objective performance, mechanical designs in IronCAD compatible format, and electronic circuit diagram schematics.

PHASE III: Further reduce size, weight, and power while designing for reliability and environmental compatibility. Build 10 preproduction units with specific DoD application(s) as target. Conduct production engineering to reduce unit price.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any branch of the military or by civilian forces for terrain mapping, building or object mapping, construction, project maintenance, design, process control, and surveillance systems.

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KEYWORDS: Laser; multi-spectral; diode; sensor; wavelength; illumination